AD-A204 382

# INSTALLATION RESTORATION PROGRAM
# PHASE II—CONFIRMATION/QUANTIFICATION
# STAGE 2

# MOODY AIR FORCE BASE, GEORGIA

Prepared by

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Gainesville, Florida 32602

## FINAL REPORT
## NOVEMBER 1988

Prepared for

TACTICAL AIR COMMAND
COMMAND SURGEON'S OFFICE (HQ TAC/SGPB)
BIOENVIRONMENTAL ENGINEERING DIVISION
LANGLEY AIR FORCE BASE, VIRGINIA 23665



UNITED STATES AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

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FOR
MOODY AIR FORCE BASE, GEORGIA 31601



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This Phase II, Stage 2 Installation Restoration Program Confirmation/Quantification survey for Moody Air Force Base, Georgia investigated four sites: Site 1, Southwest Landfill; Site 2, an underground waste fuel storage area; Site 3, the flight line storm drainage outfall area; and, Site 4, the Moody AFB water supply well at the Grassy Pond annex. Sites 1 and 4 required additional investigation as a result of the Phase II, Stage 1 investigation conducted in 1985. Sites 2 and 3 were investigated for the first time during this Stage 2 effort.

The scope of work consisted of conducting hydrogeologic investigations at Sites 1 and 2, and water quality sampling and analyses at Sites 1, 2, 3, and 4. Three deep (80 feet) wells and six shallow (30 feet) wells were installed around the perimeter of the Site 1 landfill. Seven temporary wellpoints, one standard penetration test boring, and four shallow monitor


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19. ABSTRACT (continued)

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wells (30 feet) were installed at the Site 2 waste fuel storage area. Groundwater quality samples were collected from all of the new wells at Sites 1 and 2, from two of the existing monitor wells at the Site 1 landfill, and from Moody water supply well No. 7 near Site 1. Water level, organic vapor, and floating product thickness measurements were performed on the temporary wellpoints at Site 2. Four soil samples were collected during the standard penetration test at Site 2. Surface water samples and sediment samples were collected from five different locations which could have been affected by the Site 3 flight line storm drainage outfall. Groundwater quality samples were collected from the Site 4 water supply well No. 10.

Results of the investigations were evaluated and recommendations for site classification pursuant to USAFOEHL categories were developed:

- Groundwater at Site 1 contains low levels of VOCs, cresol, naphthalene, and phenols. Levels of chromium and cadmium are above MCLs in some wells. Although no significant threats to human health or environmental quality appear imminent, additional monitoring is recommended (Category 2 classification).

- Groundwater at Site 2 is contaminated with VOCs. No floating JP-4 plume appears to exist. The unsaturated zone contains significant levels of hydrocarbons which probably serve as a continual source of contamination. Because benzene (a known human carcinogen) is present, the site is recommended for Category 3 classification and remedial action alternatives are tentatively identified.

- Sediments at Site 3 contain significant levels of petroleum hydrocarbons and lead concentrations are elevated. Surface waters do not contain significant levels of VOCs, petroleum hydrocarbons, or lead. Additional data are necessary to fully evaluate public health implications. The site is therefore recommended for Category 2 classification and additional monitoring.

- Groundwater from the Site 4 water well No. 10 contains no VOCs. Because it remains unclear whether levels of THMs previously measured are a recurring problem, additional monitoring is recommended (Category 2 classification).

gnR301B/043

# NOTICE

This report has been prepared for the United States Air Force by CH2M HILL Southeast, Inc., for the purpose of aiding in the implementation of the Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force, nor the Department of Defense.

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gnR301A/038

# PREFACE

This report presents the results of the Phase II, Stage 2 Confirmation/Quantification study conducted at Moody Air Force Base, Georgia, under the USAF Installation Restoration Program. It was prepared by CH2M HILL Southeast, Inc. under Delivery Order No. 0002, Contract No. F33615-85-D-4535.

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The contribution to the successful completion of this report of the following USAF personnel is gratefully acknowledged:

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Lana Harvey, 2nd Lt., USAF, Moody AFB
John Eiseman, Moody AFB, Base Environmental Coordinator

The field work for this project was performed from October 1986 through December 1986.

This is to certify that this report has been prepared by the undersigned or by individuals under their direct supervision. The information contained herein is true, correct, and complete to the best of their knowledge and belief.

| | |
|---|---|
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| ______________________ Signature of Project Manager/ Registered Engineer | Roy M. Duke, Jr., P.E. Florida Registration No.: ______________ |

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## EXECUTIVE SUMMARY

The Installation Restoration Program (IRP) was developed by the Department of Defense (DoD) in 1976 to assess environmental contamination and control migration of contamination that may have resulted from past operations at DoD installations. Current DoD policy on past hazardous waste disposal sites is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5 dated 11 December 1981. The policy was implemented by the Air Force by message on 21 January 1982 and consists of the following four phase program: Phase 1, Records Search/Installation Assessment; Phase II, Confirmation/Quantification; Phase III, Technology Base Development; and, Phase IV, Operations/Remedial Actions. This report presents the Phase II, Stage 2 investigations conducted by CH2M HILL at Moody Air Force Base, Georgia.

### INSTALLATION AND SITE LOCATION

Moody Air Force Base, Georgia is located about 10 miles northeast of Valdosta, Georgia on Georgia State Highway 124 (see Figure i). Three of the sites investigated by CH2M HILL during this effort are located on the southwest portion of the base (see Figure ii). These sites are:

#### Site 1--Southwest Landfill

The southwest landfill is located on approximately 30 acres of land along the southwest corner boundary of the base. From 1955 until 1972, this was the main sanitary landfill for the entire base. Some hazardous wastes, including but not limited to waste paints, thinners and solvents, may have been disposed of at this site during its active life.

#### Site 2--Underground Waste Fuel Storage Area

This underground waste fuel storage area is located at the intersection of an access road and taxiway near the aircraft maintenance facilities on the south side of the developed area of the base. In 1985, Tactical Air Command (TAC) reported that when the tank was removed, the surrounding soil was found to be contaminated with JP-4.

#### Site 3--Flightline Storm Drain Outfall

The primary storm drain pipe providing drainage for the main ramp area of the base surfaces and discharges to a swampy area located in the southwest part of the base. The swampy area drains to Mission Lake located just west of the south

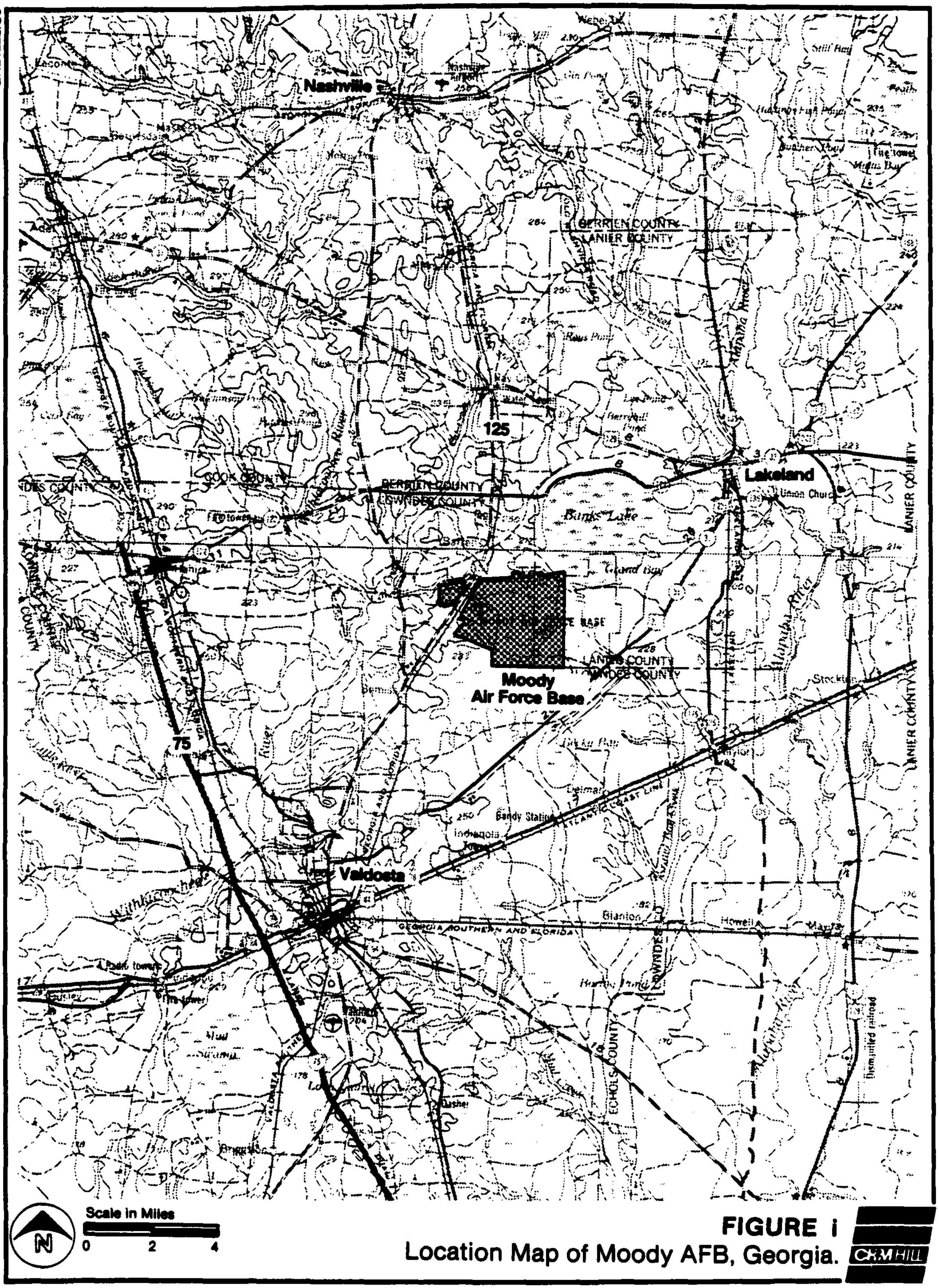


FIGURE i
Location Map of Moody AFB, Georgia.

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Site 1
Southwest
Landfill
Scale in Feet
0
200
400
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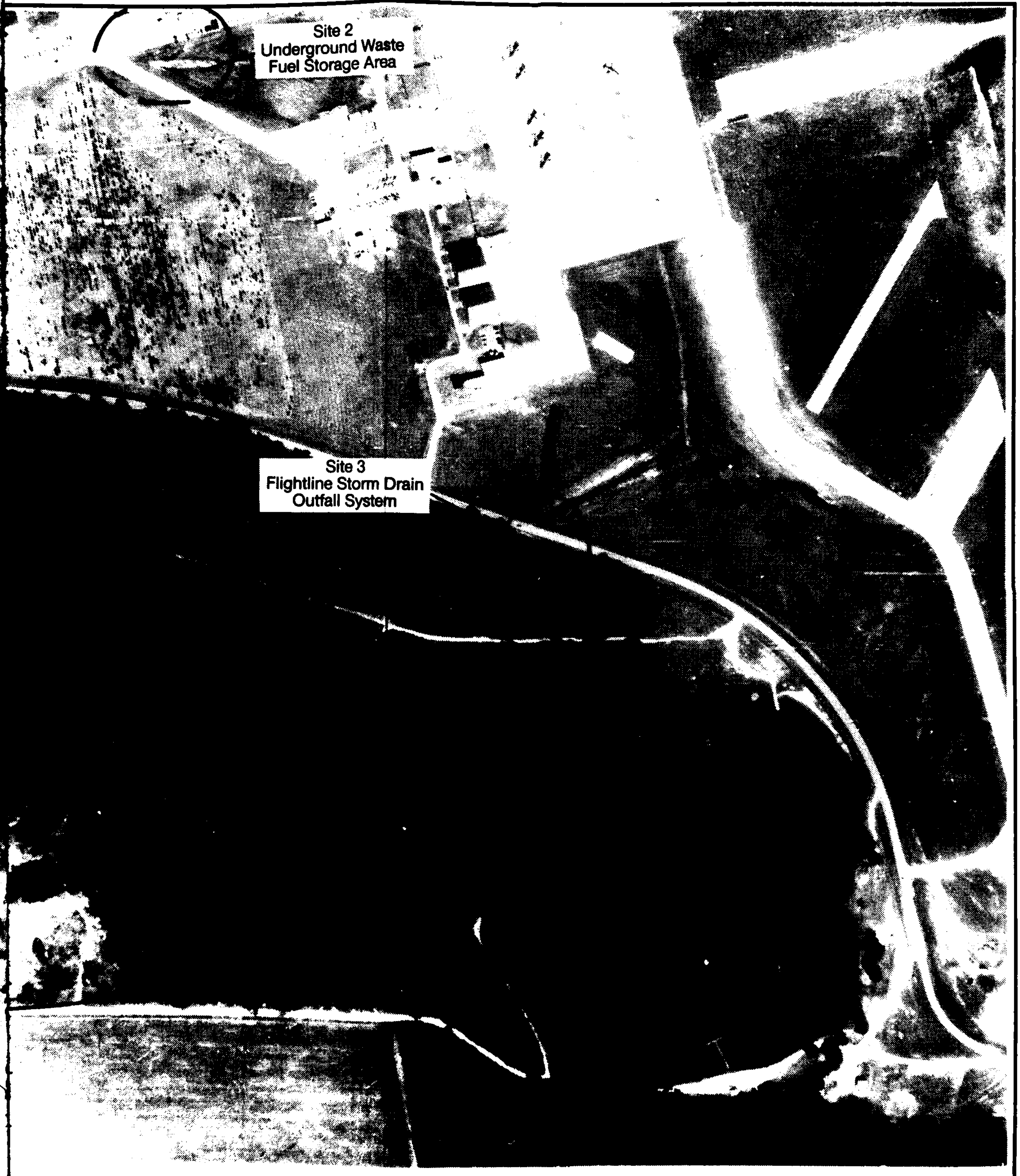


**FIGURE ii.**
Location Map for Sites 1, 2, and 3, Moody Air Force Base, Georgia.

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end of the runway. Mission Lake is used for base recreation. Visible evidence of petroleum product contamination has been observed in the swampy area near the pipe discharge area.

In addition to the three sites on base, CH2M HILL investigated Water Supply Well Number 10 at the Grassy Pond Annex, located 25 miles southwest of the base near the Georgia/Florida state line. The annex is identified as Site 4 in this report. Previous investigation of the well indicated that trihalomethane levels exceeding the maximum contamination level for drinking water existed in this well.

FIELD INVESTIGATION, RESULTS, AND CONCLUSIONS

During the field work portion of this effort, CH2M HILL conducted hydrogeological investigations at Sites 1 and 2; water quality sampling and analyses at Sites 1, 2, 3, and 4; and, soil/sediment sampling and analyses at Sites 2 and 3. Details of these investigations are presented below.

Site 1--Southwest Landfill

Three deep (80 feet) wells and six shallow (30 feet) wells were installed along the perimeter of the landfill. Two deep wells were paired with two existing shallow wells and all new wells were screened over the bottom ten feet of depth.

Boring logs were developed for each of the new wells based on the observations of a hydrogeologist present throughout the drilling operations. Generalized hydrogeologic cross-sections were developed based on these boring logs and from a previous investigation conducted by Water and Air Research, Inc. in 1984.

In situ slug tests were performed on three shallow and two deep monitoring wells to obtain estimates of lateral hydraulic conductivity in the immediate vicinity of the subsurface zones penetrated by the well screens. These tests indicated an average hydraulic conductivity of 0.60 feet per day for the zone between 20 and 30 feet below land surface (bls) and 3.0 feet per day for the zone between 70 and 80 feet bls. Average groundwater velocities in the water table aquifer are estimated to be on the order of 3 feet per year (ft/yr) in the upper aquifer and 18 ft/yr in the lower aquifer.

The nine new monitoring wells, two existing monitoring wells, and one water supply well (MSW 7) were sampled and analyzed for halogenated volatile organic compounds (VOCs); aromatic VOCs; petroleum hydrocarbons; base neutral and acid extractable compounds; priority pollutant metals; silver, mercury and selenium; and, total dissolved solids (TDS).

Groundwater at Site 1 contained low levels of VOCs, cresol, naphthalene, and phenols. Contamination appears to be concentrated primarily in the upper shallow water table in a particular area along the northeastern edge of the site. Levels of chromium and cadmium are above drinking water maximum contaminant levels (MCL) in some shallow and deep wells.

Site 2--Underground Waste Fuel Storage Area

At Site 2, the initial investigation effort centered on installation of seven temporary wellpoints placed in the areas expected to contain the heaviest contamination. Based on the information derived from the temporary wellpoints, one standard penetration test boring was installed to 20 feet bls. Split spoon samples were collected continuously during the test. The information from the temporary wellpoints was also used to locate and install four shallow (30 feet) monitoring wells; three hydraulically downgradient and one hydraulically upgradient of the location of heaviest contamination.

Slug tests were run on three of the monitoring wells in order to estimate the lateral hydraulic conductivity of the screened zone (20-30 feet bls). Analysis indicates the hydraulic conductivity ranged from 0.23-0.96 feet per day for a probable value of 0.60 feet per day. Geologic cross sections were produced from the data.

Four soil samples collected during the standard penetration tests and water samples from the four monitoring wells were collected for laboratory analyses. The samples were analyzed for aromatic volatile organic compounds and petroleum hydrocarbons. The soil samples contained concentrations of fuel constituents including benzene, ethyl benzene, toluene, and xylene with the heaviest concentrations being between four and eight feet bls. In this depth range, xylene concentrations ranged from 1.8 to 5.2 mg/kg.

No floating plume of fuel was found in any of the monitoring wells but a dissolved hydrocarbon plume does appear to exist. In the groundwater samples, the highest concentrations of dissolved constituents found were: benzene 740 ug/l; ethyl benzene 740 ug/l; and, xylene 1,600 ug/l.

Site 3--Flightline Storm Drain Outfall

Surface water samples and sediment samples were collected from five locations most expected to be most affected by the stormwater discharged by the main drain pipe and one secondary outfall.

These samples were analyzed for halogenated and aromatic VOCs, petroleum hydrocarbons, and lead. The surface waters contained only trace amounts of VOCs and very low levels of lead. The sediment samples contained relatively high concentrations of petroleum hydrocarbons and lead. Petroleum hydrocarbon concentrations ranged from 464 mg/kg to 12,800 mg/kg. Lead concentrations ranged from 1.6 mg/kg to 215.0 mg/kg.

Site 4--WSW 10 at Grassy Pond Annex

The water sample collected from WSW 10 contained no detectable levels of VOCs and the trihalomethanes (THM) found during the 1984 investigation were not confirmed.

Fate and transport analyses were done for the three sites (Sites 1, 2, and 3) on the base. Drinking water is taken from a deeper aquifer (approximately 150 feet bls). Although not investigated by this or previous Phase II efforts, available information indicates that the drinking water aquifer is well protected by the clay and marl in the upper portion of the Hawthorne formation overlying the limestone from which drinking water supplies are drawn. Because of the low hydraulic conductivity and slight gradients, it may take decades for the contaminated groundwater from Sites 1 and 2 to reach location of existing water supply wells or the swampy area surrounding Mission Lake and the lake itself.

RECOMMENDATIONS

Site 1. Additional monitoring for a minimum of 2 years. Although no significant threat to human health or environmental quality appears imminent, this conclusion is based on very limited data (2 sampling events) and organic and inorganic contamination does exist in sufficiently high concentrations to be of concern. Following semi-annual sampling and analysis for two years, the status should be re-evaluated.

Site 2. Remedial action recommended. The fate and transport analysis indicates that the contaminants may take several years to migrate to receptors and the concentrations may be significantly reduced by dilution, dispersion, and in-situ biodegradation. But, the concentrations in the soils could continue to be a source of groundwater contamination for many years. At this time, the extent of groundwater contamination appears to be relatively small and the contaminated soils are close to the surface and relatively easy to remove. Considering that benzene is a known human carcinogen, it is prudent to consider removal of a continuing source of groundwater contamination.

Site 3. Additional monitoring. Although no threat to human health or environmental quality is evident, some of the more toxic potential pollutants have not been investigated and only one set of data exists. Little or no data are available on the impact on Mission Lake where human and environmental receptors would most likely come into contact with the pollutants.

Site 4. Additional monitoring. It is recommended that the tri-annual testing for VOCs be done annually for the next three years. Although no VOCs were detected during this investigation, it is not clear that no contamination will be found since the previous investigation did find trihalomethanes (THMs) in the water. Annual checking should provide sufficient data points to determine whether a problem exists or not.

## Section 1
## INTRODUCTION

### 1.1 USAF INSTALLATION RESTORATION PROGRAM (IRP)

The Installation Restoration Program (IRP) was developed by the Department of Defense (DoD) in 1976 to assess environmental contamination and control migration of contamination that may have resulted from past operations at DoD installations. Current DoD policy on past hazardous waste disposal sites is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5 dated 11 December 1981. The policy was implemented by the Air Force by message on 21 January 1982 and consists of the following four phases:

- Phase I - Records Search. Base records are searched and base personnel are interviewed to identify possible areas of contamination on the base.
- Phase II - Confirmation and Quantification. The presence and/or migration of contaminants is confirmed or ruled out.
- Phase III - Technology Based Development. Technologies are developed to control contaminant migration or reduce contaminant levels.
- Phase IV - Corrective Action/Remediation. Identified contamination is remediated or contaminant migration is controlled.

### 1.2 PURPOSE AND SCOPE

This investigation was designed to (1) confirm the presence or absence of contamination within the specified areas of investigation; (2) if possible, determine the extent, degree of contamination, and the potential for migration of those contaminants in the environment; (3) identify public health and environmental hazards of stationary or migrating pollutants based on state or federal standards for those contaminants; and (4) recommend whether additional actions should be taken with respect to the sites investigated. The following specific sites were investigated during this study:

Site 1. Southwest Landfill

Site 2. Underground Waste Fuel Storage Area

Site 3. Flightline Storm Drainage Outfall Area

Site 4. Moody AFB Water Supply Well No. 10 at Grassy Pond Annex

Sites 1, 2, and 3 are located on the base property, as shown in Figure 1. Grassy Pond Annex is located about 25 miles southwest of the base near the Florida-Georgia state line, west of Interstate 10. The site map for the Annex is shown in Figure 2.

## 1.3 HISTORY OF THE INSTALLATION RESTORATION PROGRAM AT MOODY AFB

Two IRP efforts relevant to one or more of the sites investigated by this study have been previously conducted at Moody AFB. These studies are summarized below.

### 1.3.1 IRP PHASE I RECORDS SEARCH

CH2M HILL performed the Phase I records search from September 1982 to February 1983 under Contract Number F08637-80-G0010-5W01. The final report, which is dated February 1983, included a detailed review of pertinent installation records, contacts with 19 government organizations for documents relevant to the records search effort, and an onsite base visit. During the onsite base visit, 43 past and present base employees were interviewed, potential contamination sites inspected from the ground and by helicopter overflight, and installation records reviewed in detail.

The records search identified 14 potentially contaminated sites (see Figure 3). Of these, the records indicated that there was no reason to suspect hazardous wastes had ever been delivered or deposited on five of the sites (Sites 9, 10, 11, 13, and 14, Figure 3). The remaining nine sites were rated and ranked, as shown in Table 1, using the site rating methodology described in Appendix I. The site rating form used during this Phase II, Stage 2 effort is also included in Appendix I.

The Southwest Landfill is the only site common to the Phase I and this Phase II, Stage 2 study. Pertinent data from the Phase I effort has been integrated into this report. Specific data sheets taken from the Phase I report are included in Appendix J.

### 1.3.2 IRP PHASE II, STAGE 1 CONFIRMATION/QUANTIFICATION INVESTIGATION

From January 1984 to October 1984, Water and Air Research Inc. (WAR), under Contract Number F33615-D-4007, Delivery


Site 1
Southwest
Landfill
Scale in Feet
0 200 400
N

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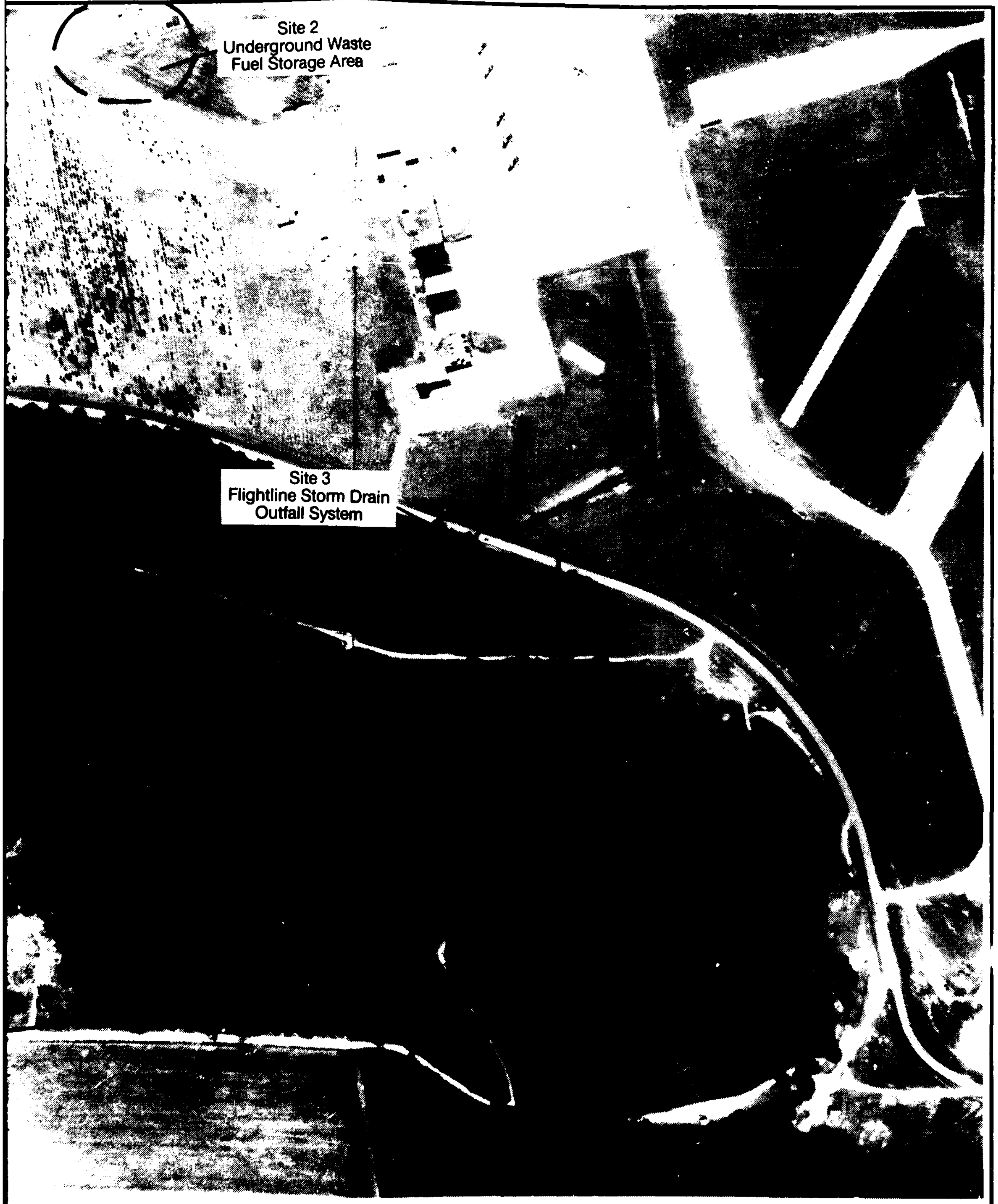


**FIGURE 1.**
Location Map for Sites 1, 2, and 3, Moody Air Force Base, Georgia.

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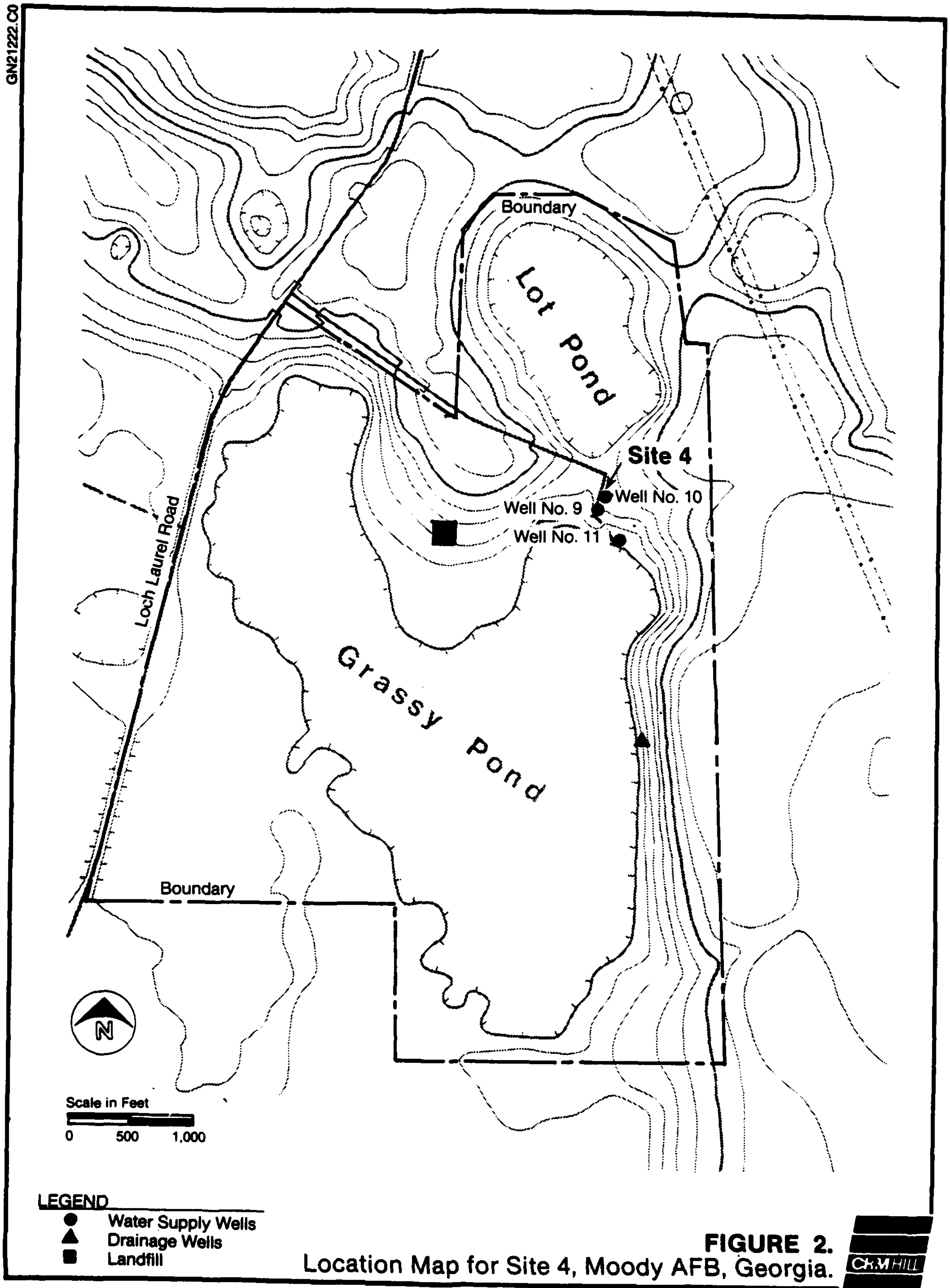


**FIGURE 2.**
Location Map for Site 4, Moody AFB, Georgia.

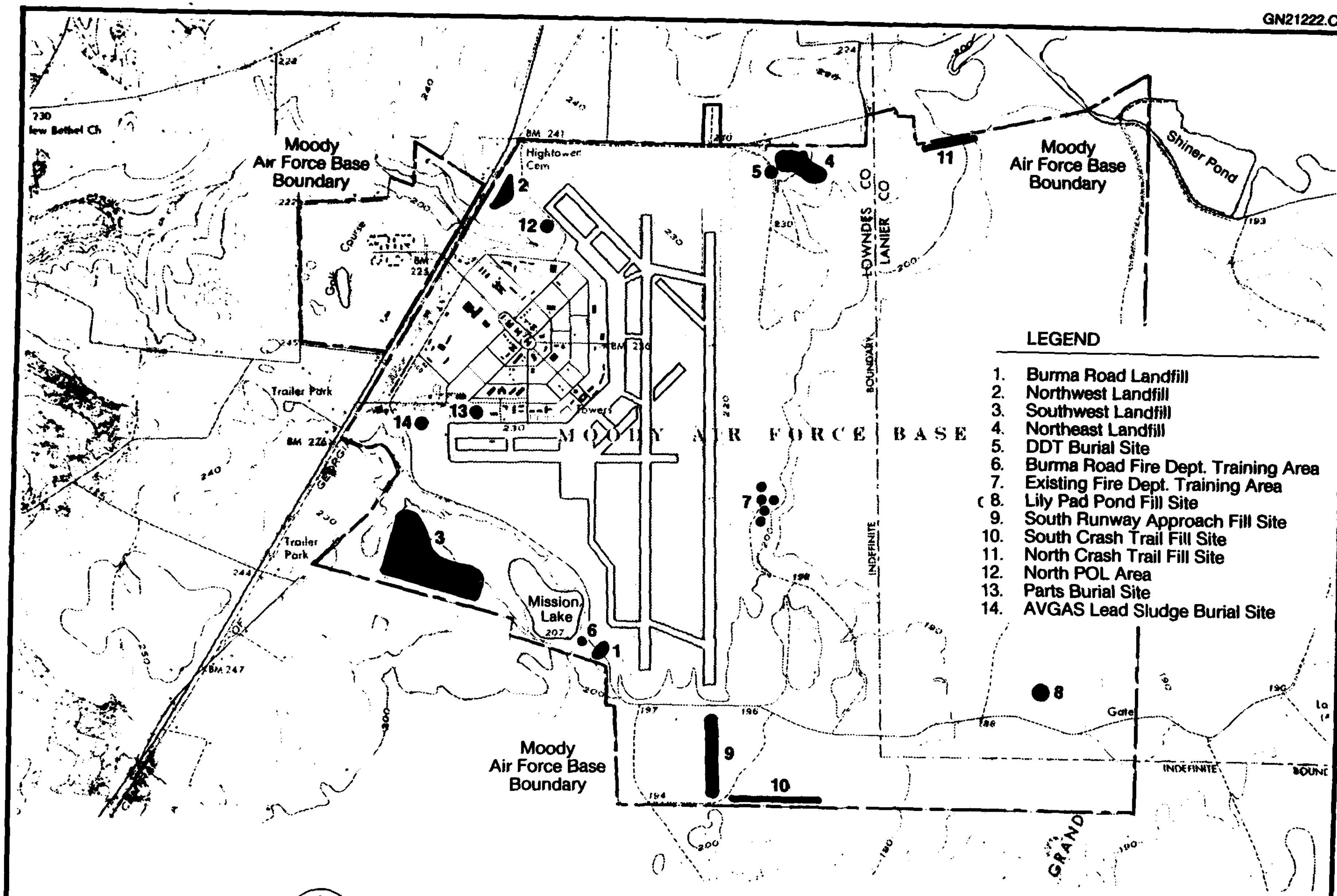


**FIGURE 3.**
Location Map of Identified Disposal and Spill Sites,
Moody AFB, Georgia.

Table 1
PRIORITY LISTING OF DISPOSAL SITES
MOODY AFB, GEORGIA

| Site Number | Site Description | HARM Overall Score |
|---|---|---|
| 3 | Southwest Landfill | 56 |
| 8 | Lily Pad Pond Fill Site | 56 |
| 12 | North POL Tank Farm | 55 |
| 5 | DDT Burial Site | 53 |
| 6 | Burma Road Fire Department Training Area | 52 |
| 7 | Existing Fire Department Training Area | 51 |
| 1 | Burma Road Landfill | 49 |
| 4 | Northeast Landfill | 49 |
| 2 | Northwest Landfill | 45 |

Order No. 0014, performed a Phase II, Stage 1 investigation of the three sites having the highest score based on the hazardous assessment rating methodology (HARM). The sites were the Southwest Landfill, the Lily Pad Pond fill area, and the North POL Tank Farm, which are designated as Sites 3, 8, and 12, respectively, in Figure 3. In addition, WAR tested all existing water supply (potable and industrial) wells including Well 10 at the Grassy Pond Annex. WAR concluded that additional monitoring and investigation was needed at the Southwest Landfill to "refine estimates of substances moving in groundwater." They also indicated that Water Supply Wells 7 and 10 had total organic halogen (TOX) levels of 120 and 94 micrograms per liter ($\mu g/l$), respectively, and required additional testing. These recommendations were implemented and additional investigation of the Southwest Landfill and additional testing of Water Supply Wells 7 and 10 are part of this Phase II, Stage 2 study. Data collected by WAR on these sites have been integrated with data collected during this investigation and are provided in Appendix J.

Since the same labeling protocol was not followed in reports referenced above, the site numbers used in the three separate studies are cross-referenced in Table 2.

### 1.3.3 FACILITY DESCRIPTION AND HISTORY

Moody AFB is located on 5,160 acres of land in Lowndes and Lanier Counties in south-central Georgia. Nearby towns include Valdosta, about 10 miles to the southwest, and Lakeland, about 6 miles to the northeast (Figure 4). The closest large cities include Atlanta, Georgia, 234 miles to the north, and Jacksonville, Florida, about 120 miles to the southeast. Georgia State Highway 124 is the access road to Moody AFB, and U.S. Interstate Highway 75 passes about 10 miles to the west of the base. The current base boundaries are shown in Figure 5.

The Grassy Pond Recreational Annex is located 25 miles southwest of Moody AFB, just 3 miles north of the Georgia/ Florida state line (Figure 2). This site consists of approximately 500 acres of land originally sold to the United States Government in 1928 for use as a fish hatchery. Major surface features at the site include Grassy Pond (160 acres), Lot Pond (30 acres), and over 300 acres of upland forest and developed areas.

Moody AFB was established in 1941 as an advanced pilot training school for Army Air Corps cadets. The original base boundaries included over 9,000 acres of land acquired by use permit from the United States Department of Agriculture and by lease. In 1946, following the end of World War II, Moody AFB was placed on inactive status until it was reopened in 1951 after the outbreak of the Korean

Table 2
SITE NUMBER CROSS REFERENCE
MOODY AFB, GEORGIA

| Site Description | Site Numbers: CH2M HILL Phase I | Site Numbers: WAR, Inc. Phase II, Stage 1 | Site Numbers: CH2M HILL Phase II, Stage 2 |
|---|---|---|---|
| Southwest Landfill | 3 | 1 | 1 |
| Waste Fuel Storage Area | NA* | NA | 2 |
| Flightline Storm Drain Outfall | NA | NA | 3 |
| Moody Water Supply Well 7 | NA | MAFB 7 | 1 (MSW 7) |
| Moody Water Supply Well 10 | NA | MAFB 10 | 4 (MSW 10) |

*NA: Not applicable.

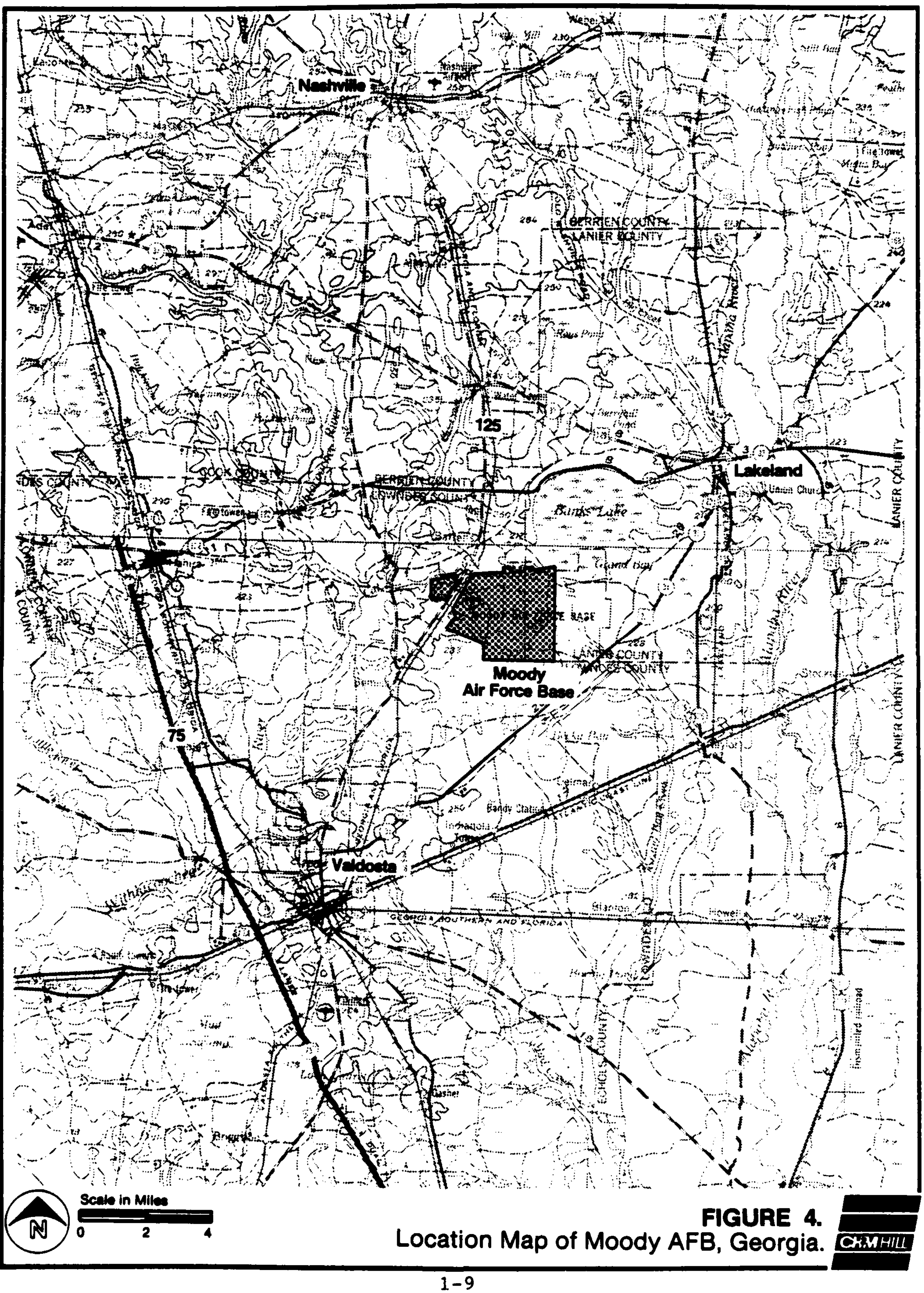


**FIGURE 4.**
Location Map of Moody AFB, Georgia.

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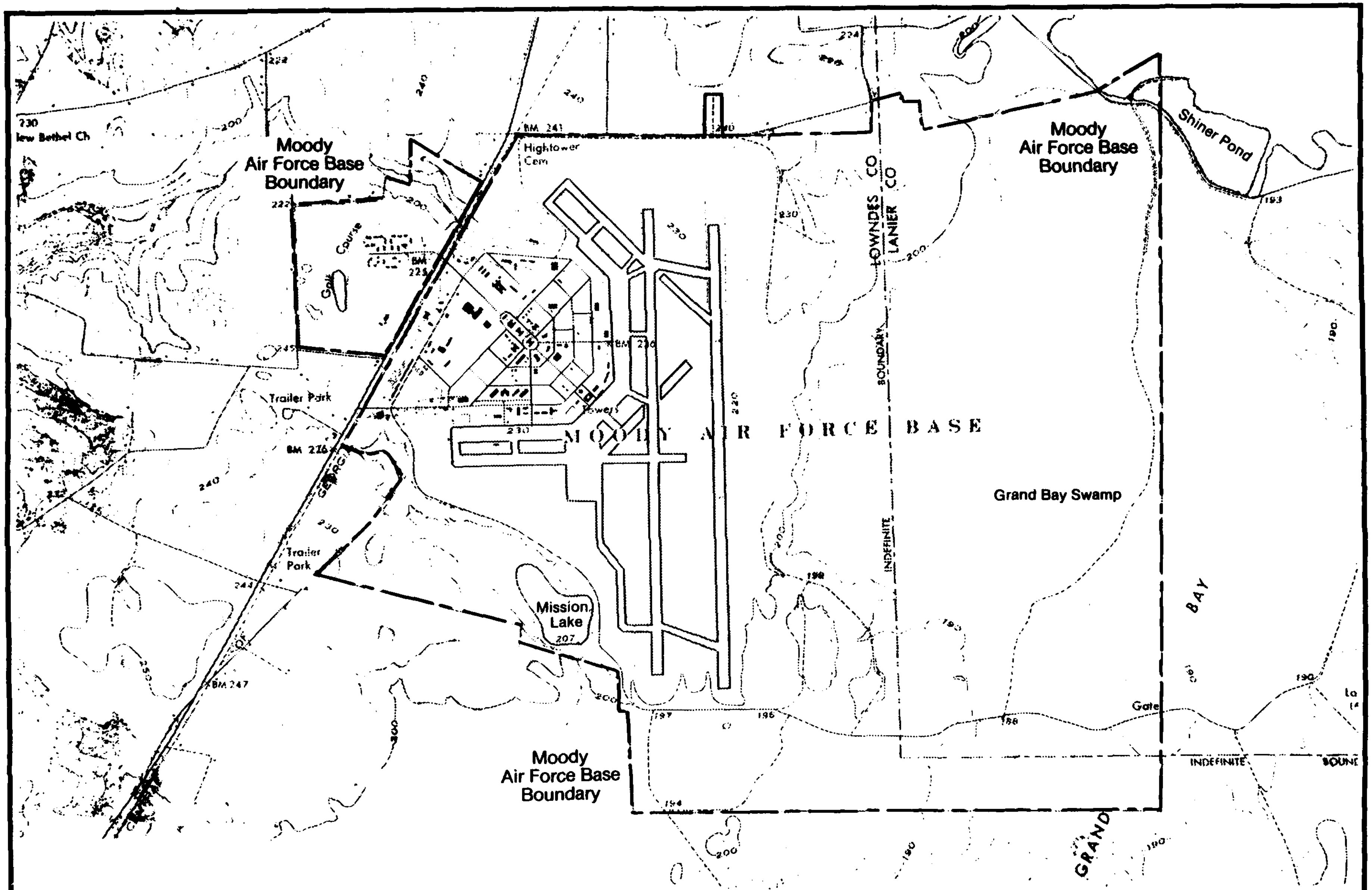


**FIGURE 5.**
Map of Moody AFB, Georgia.

conflict. From that time until 1975, Moody AFB was primarily involved in pilot training under the Air Training Command (ATC), with pre-flight, primary, and basic pilot training programs. In late 1975, ATC deactivated the 38th Flying Training Wing at Moody AFB, and the base was reassigned to Tactical Air Command (TAC) and the 347th Tactical Fighter Wing (TFW).

The majority of industrial operations at Moody AFB have been and continue to be associated with maintenance of aircraft engines, aircraft hydraulic systems, wheels and tires, aerospace ground equipment, and corrosion control. These industrial operations have generated among other things, varying quantities of waste oils, fuels, solvents, and cleaners. The total quantity of these wastes historically ranged from 25,000 to 50,000 gallons per year. The standard procedures for the final disposition of the majority of the waste oils, fuels, and solvents has been (1) fire department training exercises (1941-1946); (2) fire department training exercises, contractor collection and removal, and discharge to sanitary sewers and storm drains (1955-1975); and (3) segregation and conveyance to the Defense Property Disposal Office (DPDO) for off-base disposal (1975 to present).

## 1.4 DESCRIPTION AND HISTORY OF INDIVIDUAL SITES

### 1.4.1 SITE 1. SOUTHWEST LANDFILL

The Southwest Landfill is located on approximately 30 acres of land along the southwest corner boundary of Moody AFB, west of Mission Lake (Figure 1). From 1955 until 1972, this was the main sanitary landfill for the entire base. Small quantities of hazardous wastes, including but not limited to waste paints, thinners, and solvents may have been disposed of at this site during its operation.

The operational procedures at the landfill used the trench and fill method. Trenches about 14 feet deep were excavated and backfilled with waste then covered with soil. Tail ditches were dug for collection of surface runoff and are still evident. Loblolly pines have been planted over much of the filled area. Some organic debris (leaves, branches, and grass clippings) are deposited at this site and some sludge from the sewage treatment plant has been composted. No specific measures have been taken to minimize infiltration of stormwater through the deposited wastes.

WAR conducted an IRP Phase II, Stage 1 investigation of this site from January 1984 to October 1984 and published the final report on the investigation in December 1985. Six 2-inch diameter monitoring wells were installed at the

landfill site to depths of approximately 25 feet below land surface (bls). One of the wells is located upgradient of the landfill and the remaining five are around the downgradient perimeter of the landfill. These wells were sampled and analyzed for groundwater contamination indicators, metals, pesticides, and volatile organic compounds (VOC's). WAR's analytical results (see Appendix J) indicated that the pH was in the mildly acidic range, specific conductance varied from 23 micromhos per centimeter (μmhos/cm), to 728 μmhos/cm, and dissolved organic carbon (DOC) and chemical oxygen demand (COD) results showed little variability among the wells. Metals were generally not detected at significant levels at any well. Very low concentrations (well below regulatory maxima) of barium and mercury were found, with the levels in the upgradient and downgradient wells being within one order of magnitude of each other. Levels of other metals were below the detection limits for the analytical method used. No detectable levels of pesticides or herbicides were found in any well at the site. Analysis of VOC's indicated detectable amounts of: chlorobenzene, 1,4-dichlorobenzene, trichloroethene, and benzene. All concentrations were less than 10 μg/l.

Samples taken during this Phase II, Stage 2 investigation were analyzed for halogenated organic volatiles, aromatic volatile organics, extractable priority pollutants, petroleum hydrocarbons, priority pollutant metals, selenium, arsenic, mercury, and total dissolved solids (TDS). The results of these analyses and those from the previous WAR analyses are presented and evaluated in Section 4.

### 1.4.2 SITE 2--UNDERGROUND WASTE FUEL STORAGE AREA

As shown previously in Figure 1, the underground waste fuel storage area is located at the intersection of an access road and taxiway near the aircraft maintenance facilities on the south side of the developed area of the base. In a letter dated 20 May 1985, the TAC reported that, when the storage tank was removed, the surrounding soil was found to be contaminated with JP-4. The extent of contamination is unknown, although the tank was emptied periodically. No previous sampling or analyses have been performed on the soils or groundwater in this area.

During this investigation, soil and water samples were collected and analyzed for aromatic volatile organics and petroleum hydrocarbons. The results of the analyses and an evaluation of the data are discussed in Section 4.

### 1.4.3 SITE 3. FLIGHTLINE STORM DRAIN OUTFALL

The primary storm drain pipe providing drainage for the ramp areas of the base near the maintenance areas surfaces and

ends a short distance to the north of Burma Road between the main ramp and Mission Lake. The drainage ditch continues to the south, passing under a bridge on Burma Road and thence into a small swamp that drains into Mission Lake. The location of the area was previously shown as Site 3 in Figure 1. Between Burma Road and Mission Lake, an unimproved road interrupts the flow. The culverts or pipes beneath the unimproved road are at or below surface water levels in the swamp. Consequently, the unimproved road acts as an oil-water separator and oils and greases have been visible on the surface of the water. Two other less significant drainage paths are located to the west of the main drainage channel. These drainage paths also drain a portion of the maintenance ramp area and empty into the swamp to the west-northwest of Mission Lake. No existing sampling or analyses of the waters of the drainage channels, the swamp, or the sediments are available.

Surface water and sediments were sampled at five points in areas potentially affected by the storm water drainage. The samples were analyzed for halogenated volatile organics, aromatic volatile organics, petroleum hydrocarbons, and lead. The results of the analyses and an evaluation of the data are presented in Section 4.

### 1.4.4 SITE 4. WATER SUPPLY WELL NUMBER 10 AT GRASSY POND ANNEX

The Moody AFB Water Supply Well Number 10 is located at the Grassy Pond Recreational Annex, which was previously described and shown in Figure 2. Water Supply Well Number 10 is reported to be 140 feet deep. The sampling and analysis WAR conducted during their Phase II, Stage 1 study showed TOX levels of 94 μg/l and DOC levels of 4.9 milligrams per liter (mg/l).

As part of this investigation, the well was sampled and analyzed for halogenated volatile organics and aromatic volatile organics. The results of these analyses and those from the previous WAR analyses are presented and evaluated in Section 4. Data supplied by the base from their regular monitoring program are also included.

## 1.5 PROJECT TEAM

The project team formed for this project comprised personnel from four divisions within CH2M HILL. Personnel from the Gainesville, Florida office conducted the primary effort and all of the field work. The key personnel and their functions are shown on the organization chart in Figure 6. The following individuals were key members of the project team:

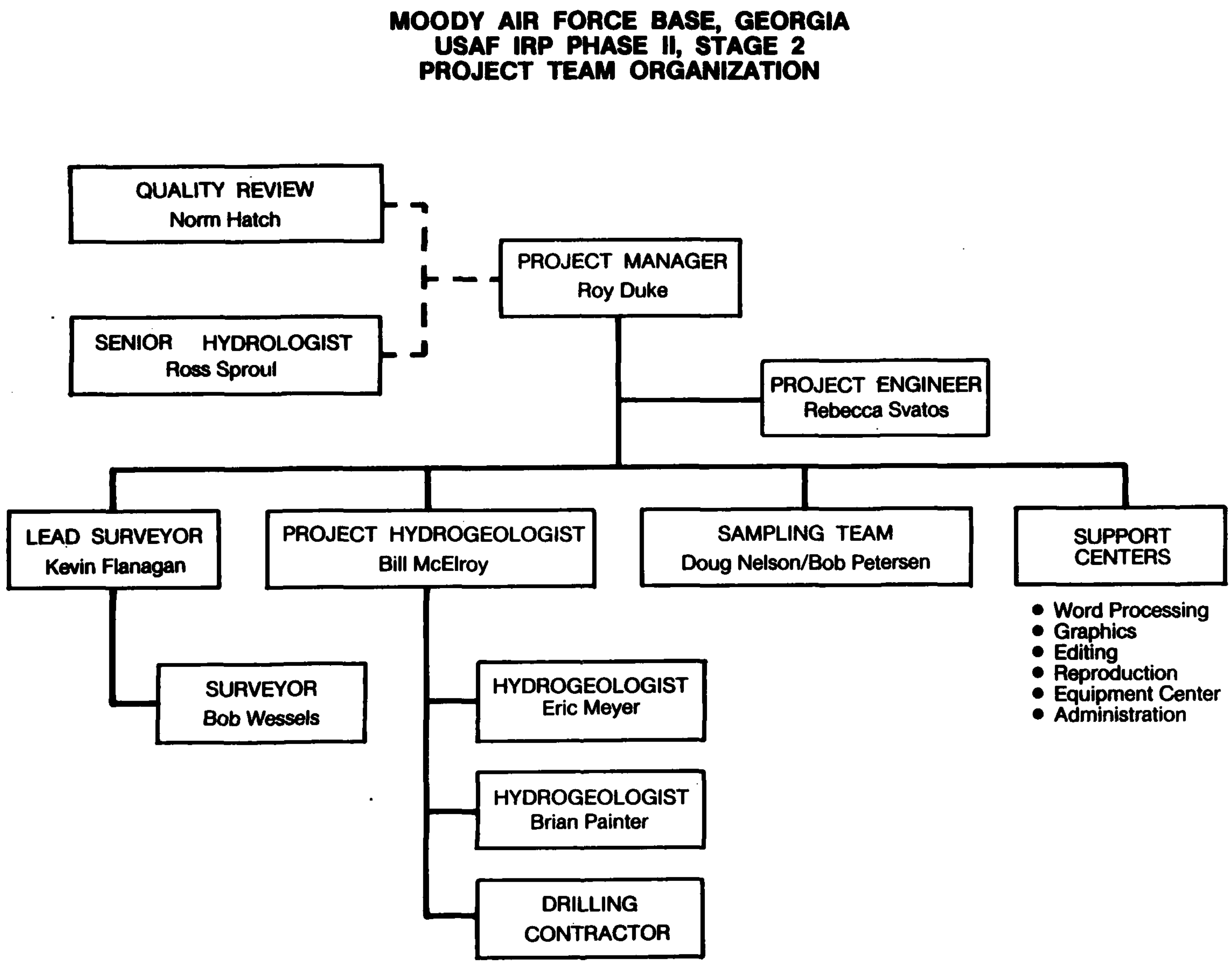


**FIGURE 6.**
Project Organization Chart.

Roy Duke--Project Manager (M.S. Industrial Engineering)

Norman Hatch--Quality Review (M.S. Chemistry; M.S., Environmental Engineering)

Ross Sproul--Senior Hydrologist (B.S., Geology)

Bill McElroy--Project Hydrogeologist (B.S., Environmental Engineering; B.S., Physical Geography)

Becky Svatos--Project Engineer (M.S., Environmental Engineering)

Eric Meyer--Hydrogeologist (B.S., Geology)

Brian Painter--Hydrogeologist (M.S., Hydrogeology)

Doug Nelson--Sample Team Leader (A.S., Environmental Sciences)

The drilling contractor was Liberty Drilling, Testing and Boring, Inc., from Ocala, Florida.

## Section 2
## ENVIRONMENTAL SETTING

### 2.1 PHYSICAL GEOGRAPHY

Moody AFB is located in the Atlantic Coastal Plain (see Figure 6A), which is characterized by flat to sloping plateaus, shallow river valleys, and broad wetland depressions. The Withlacoochee River lies to the west of the base, and the Alapaha River lies to the east. Surface elevations on the base range from approximately 190 feet mean sea level (msl) in the eastern part of the base in the Grand Bay Swamp to 250 feet msl near the center of the base.

### 2.2 SURFACE WATER HYDROLOGY

The major surface-water features and drainage patterns at Moody AFB are shown in Figure 7. Surface drainage from the base eventually enters the Suwannee River in Florida before draining into the Gulf of Mexico. Major hydrologic features on the base include Mission Lake, Grand Bay Swamp, and Beatty Creek, which receives treated effluent from the base wastewater treatment plant.

### 2.3 METEOROLOGY

The humid subtropical climate of Moody AFB is characterized by long, humid summers and short, mild winters. The average annual temperature in the region is 68° F with a recorded maximum temperature of 104° F and a recorded minimum of 9° F. The annual average relative humidity is 68 percent. Annual rainfall at Moody AFB averages 47 inches and is distributed relatively evenly throughout the year. Summer is generally the wettest season with thundershowers occurring almost every afternoon in July and August. Annual lake evaporation is estimated to be between 40 and 45 inches in the base area.

### 2.4 ECOLOGY

Over 3,000 acres of Moody AFB are unimproved and host a variety of wildlife habitats, including upland pine forests, pine flatwoods, gum-bay-shrub swamps, and freshwater ponds. Approximately 1,400 acres of pine forest on the base are managed by the U.S. Forest Service. Approximately 1,600 acres of wetland habitat in Grand Bay Swamp are not managed, and sweetbay, black gum, evergreen shrubs and vines, pond pine, and cypress are all present. A hardwood hammock in this unmanaged area called Dudley's Hammock, contains magnolia, hickory, and oak trees.

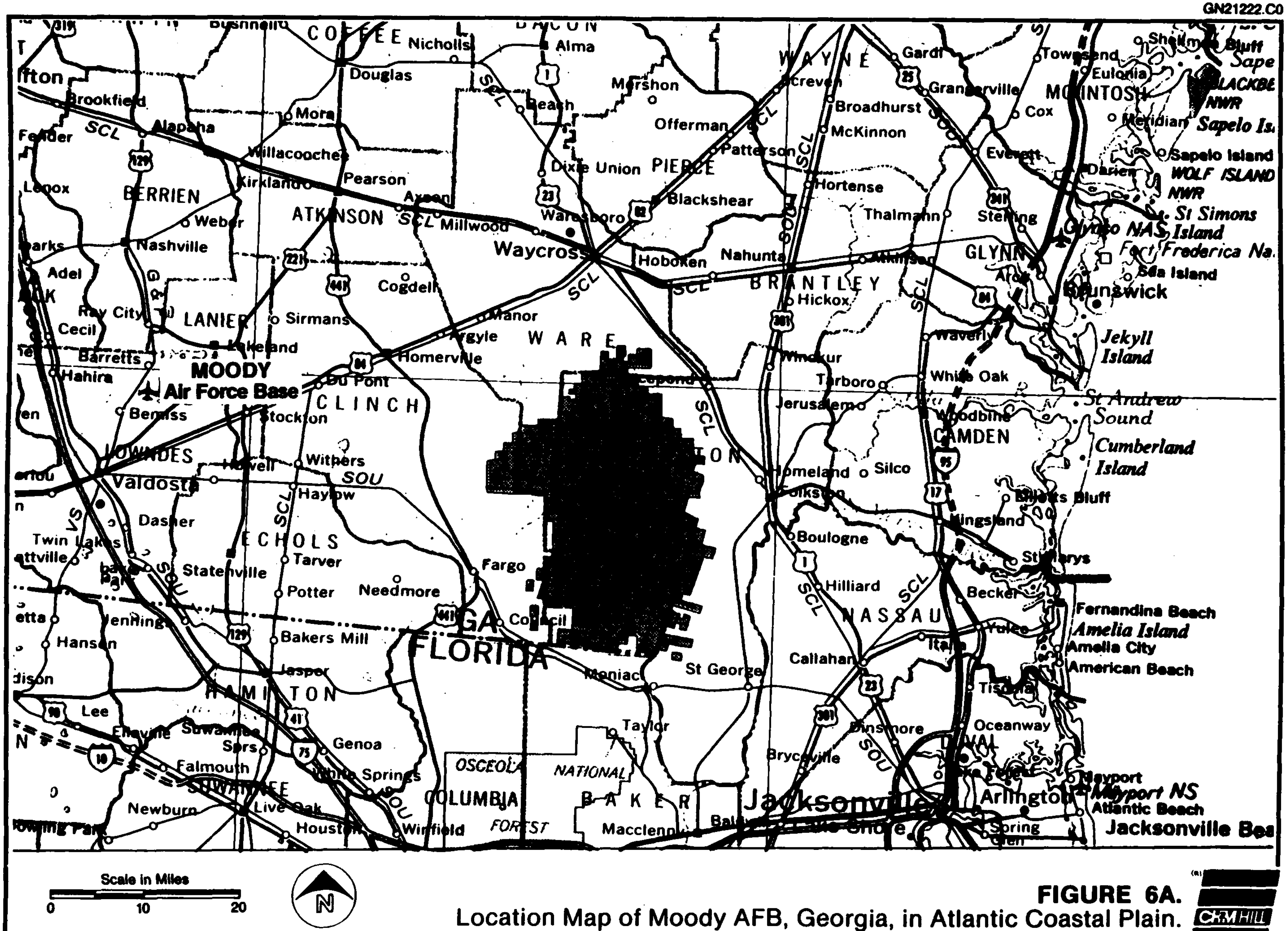


**FIGURE 6A.**
Location Map of Moody AFB, Georgia, in Atlantic Coastal Plain.

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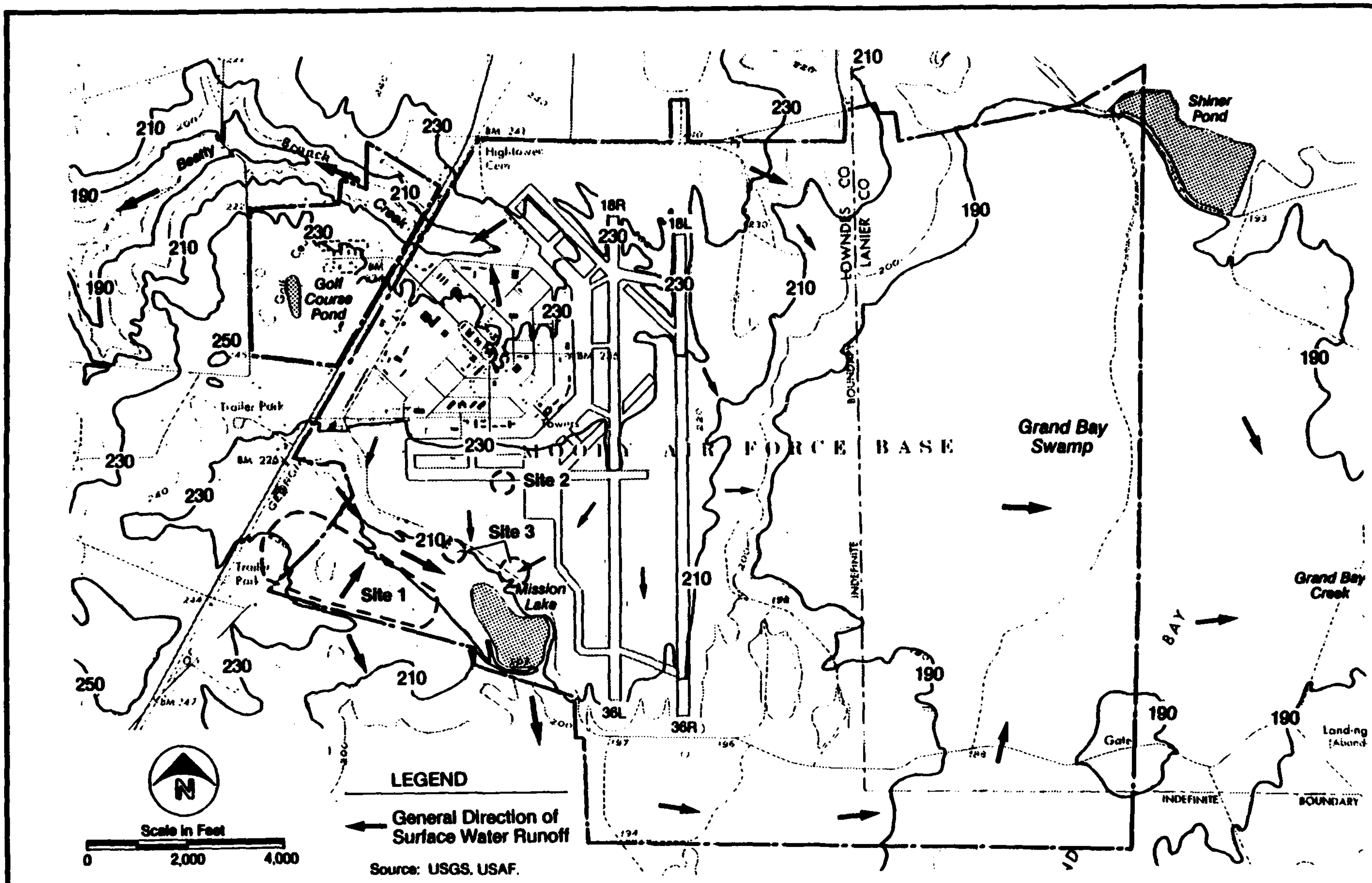


FIGURE 7.
Topography and Surface Water Feature Map, Moody AFB, Georgia.

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Abundant wildlife on the base include over 100 species of birds and many common mammals. Deer hunting is currently allowed on the base and turkey and small game hunting may be allowed in the future. Threatened and endangered species reported to occur on or near Moody AFB include the Florida panther, peregrine falcon, southern bald eagle, American alligator, red-cockaded woodpecker, and indigo snake. Several threatened and endangered plant species are reported to occur in the wetlands areas of the base.

## 2.5 SOILS

In the western part of the base, approximately 2 to 5 feet of well-drained, loamy fine sands overlie sandy clays and clayey sands. The surficial soils have moderate to high permeabilities ranging from $10^{-4}$ to $10^{-2}$ centimeters per second (cm/sec). The underlying soils have moderate to low permeabilities ranging from $10^{-4}$ to $10^{-6}$ cm/sec. The soils in the Grand Bay Swamp area are the poorly drained organic soils associated with wetland plant communities. A soils map of Moody AFB is shown in Figure 8.

## 2.6 GEOLOGY

A geologic map of the Moody AFB vicinity is shown in Figure 9 and the major stratigraphic units are shown in cross-section in Figure 10. In the Moody AFB area, the youngest geologic formation outcropping, excluding surface sands, is the Miccosukee Formation of Late Miocene age. Over most of the base, the Miccosukee is overlain by up to 30 feet of undifferentiated sandy deposits. These surficial sands consist of Pleistocene terrace deposits or material reworked from the underlying Miccosukee Formation.

The Miccosukee Formation consists primarily of red-brown, orange and yellow clayey sand, sandy clay and silt. From boring work performed during this investigation, a 5- to 15-foot thick stratum of fine to coarse sand with gravel and some pebble phosphate is present at the base of the formation. This coarse basal unit is probably material reworked from the underlying Hawthorn Formation. The total thickness of the Miccosukee Formation and overlying surficial material ranges from about 75 to about 125 feet in the vicinity of the base. In the western base area, the Miccosukee Formation is about 80 feet thick.

The oldest stratum penetrated by test borings performed during this study was a dense greenish clay marl, the uppermost unit of the Hawthorn Formation of Middle Miocene age. The Hawthorn Formation is about 150 feet thick at Moody AFB. The formation is composed of phosphatic clay, claystone,

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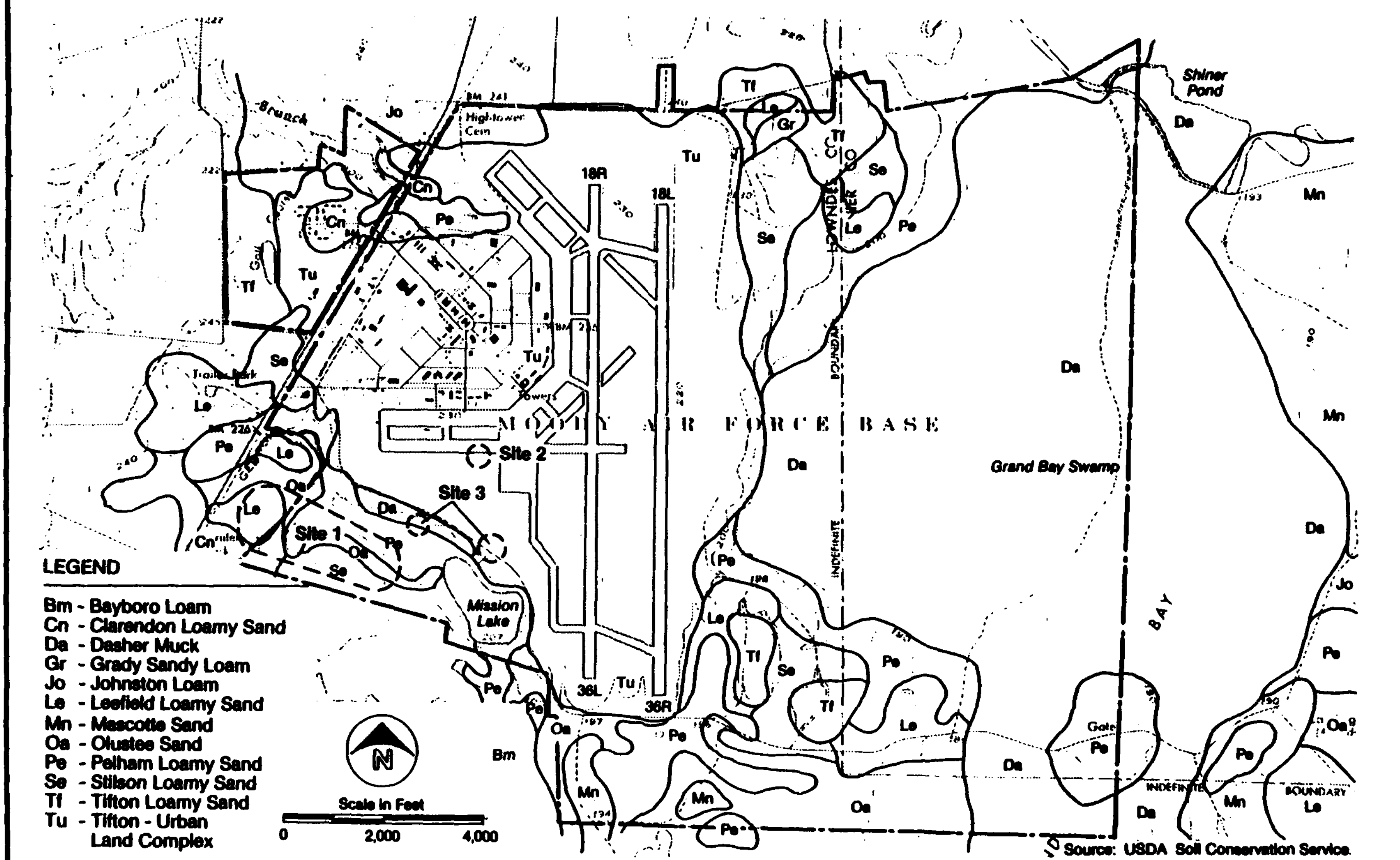


**FIGURE 8.**
Surficial Soils Map, Moody AFB, Georgia.

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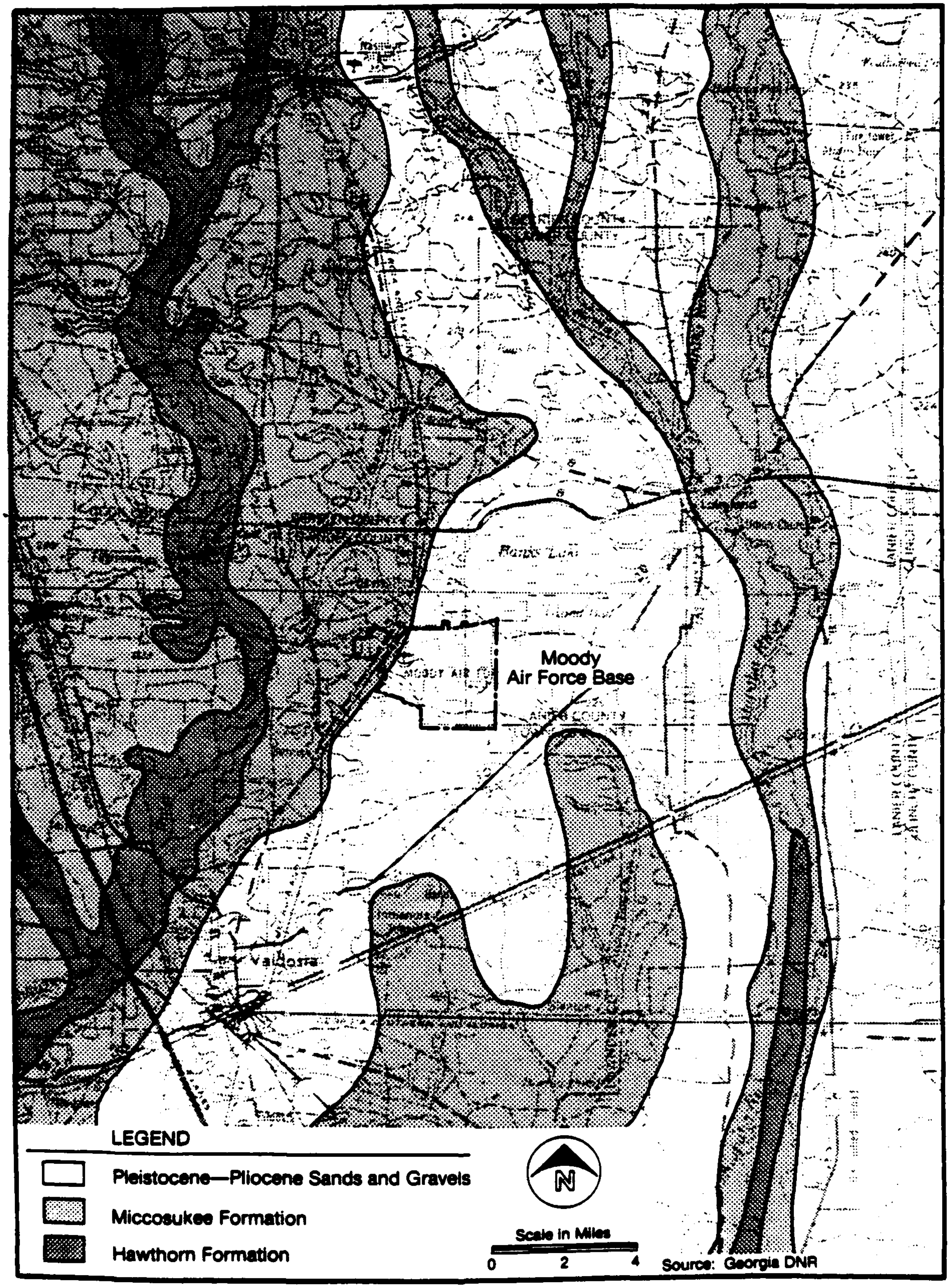
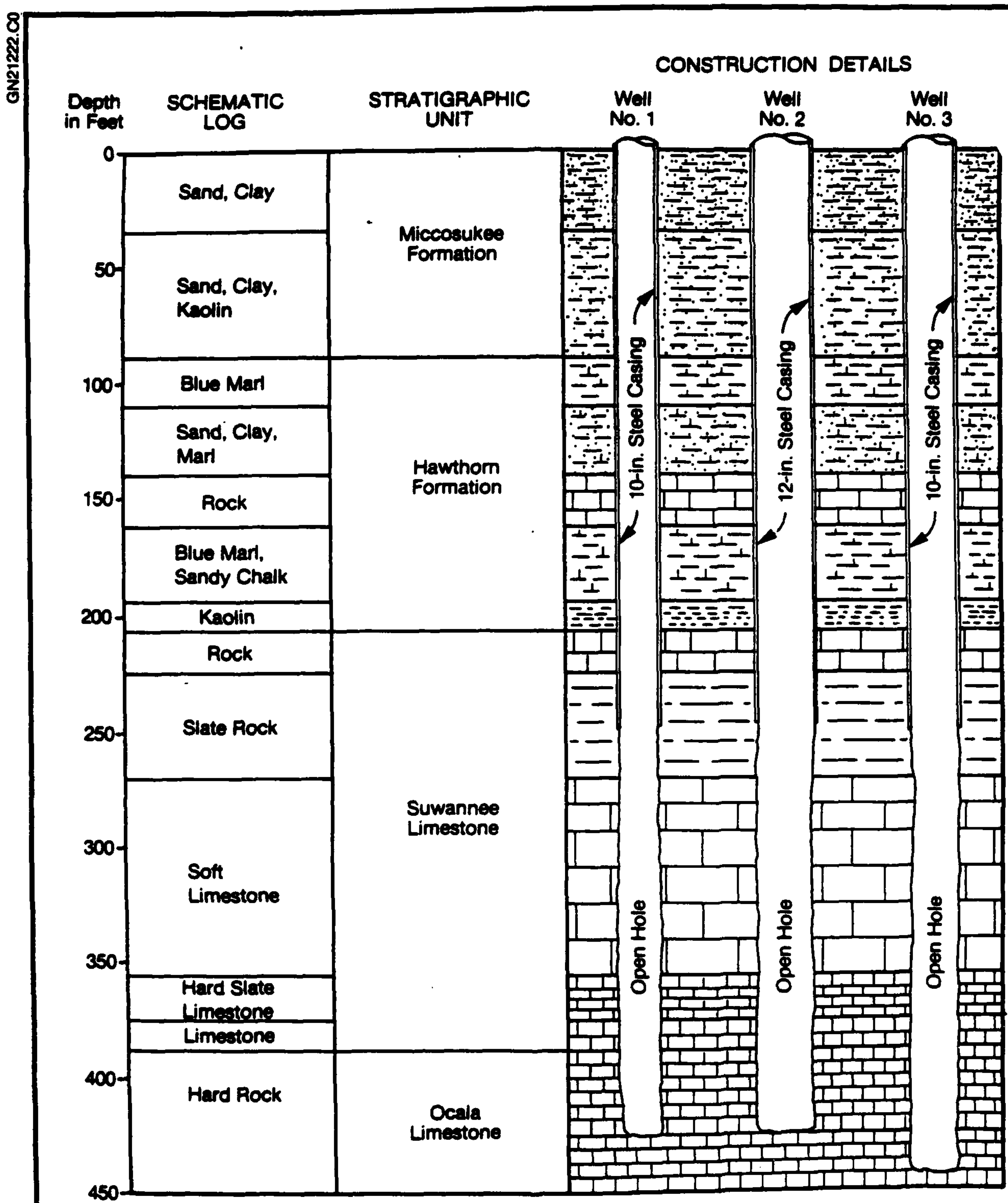



**FIGURE 9.**
Geologic Map, Moody AFB, Georgia.




Note: All wells are located near Georgia State Highway 125 on Moody AFB.
Source: USAF.

**FIGURE 10.**
Schematic of Stratigraphy and Construction of Major Potable Water Wells, Moody AFB, Georgia.

sand, marl, and limestone in the upper part. The lower 20 to 60 feet of the Hawthorn is reported to consist of brown cherty, sandy limestone that is highly permeable. The latter stratum is probably the uppermost unit of the regional tertiary limestone aquifer system.

Several hundred feet of nearly-pure limestone underlie the Hawthorn Formation. This limestone, which includes the Oligocene-age Suwannee and the Eocene-age Ocala, comprises the regional tertiary limestone aquifer from which the base water supply wells draw their water.

## 2.7 HYDROGEOLOGY

At Moody AFB, groundwater occurs under water table or perched water table conditions within the Miccosukee Formation. In the western part of the base, the water table is reportedly 10 to 20 feet bls, while in the eastern part of the base the water surface elevation varies from land surface to about 10 feet bls. Recharge of this water table aquifer is generally through infiltration, causing water levels to vary seasonally in response to rainfall.

The Miccosukee Formation is comprised of numerous strata of subsurface materials with zones of relatively high permeability occurring between less permeable layers. Two particular units of relatively high permeability were identified in Site 1 test borings performed during this study. The upper unit consists of about 10 feet of fine sand and sandstone and occurs between approximately 45 and 55 feet bls. The second unit is the basal zone of sands, gravel and pebble phosphate previously described. The more permeable zones comprise the surficial (water table) aquifer system. Field data collected during this investigation indicates that groundwater in the surficial aquifer is moderately to mildly acidic.

The surficial aquifer is separated from the underlying limestone aquifer by clay and marl in the upper portion of the Hawthorn Formation. Although this portion of the Hawthorn is relatively impermeable, it allows some water to pass from the surficial water table aquifer to the limestones below.

The lower part of the Hawthorn Formation, the Suwannee Limestone, and the Ocala Limestone, comprise the principal artesian aquifer in the Moody AFB vicinity. This aquifer is present at a depth of approximately 150 feet bls and is the main water-bearing unit in the area.

The May 1975 potentiometric surface of the principal artesian aquifer around Moody AFB is shown in Figure 11. Groundwater flow in the artesian aquifer is generally to the

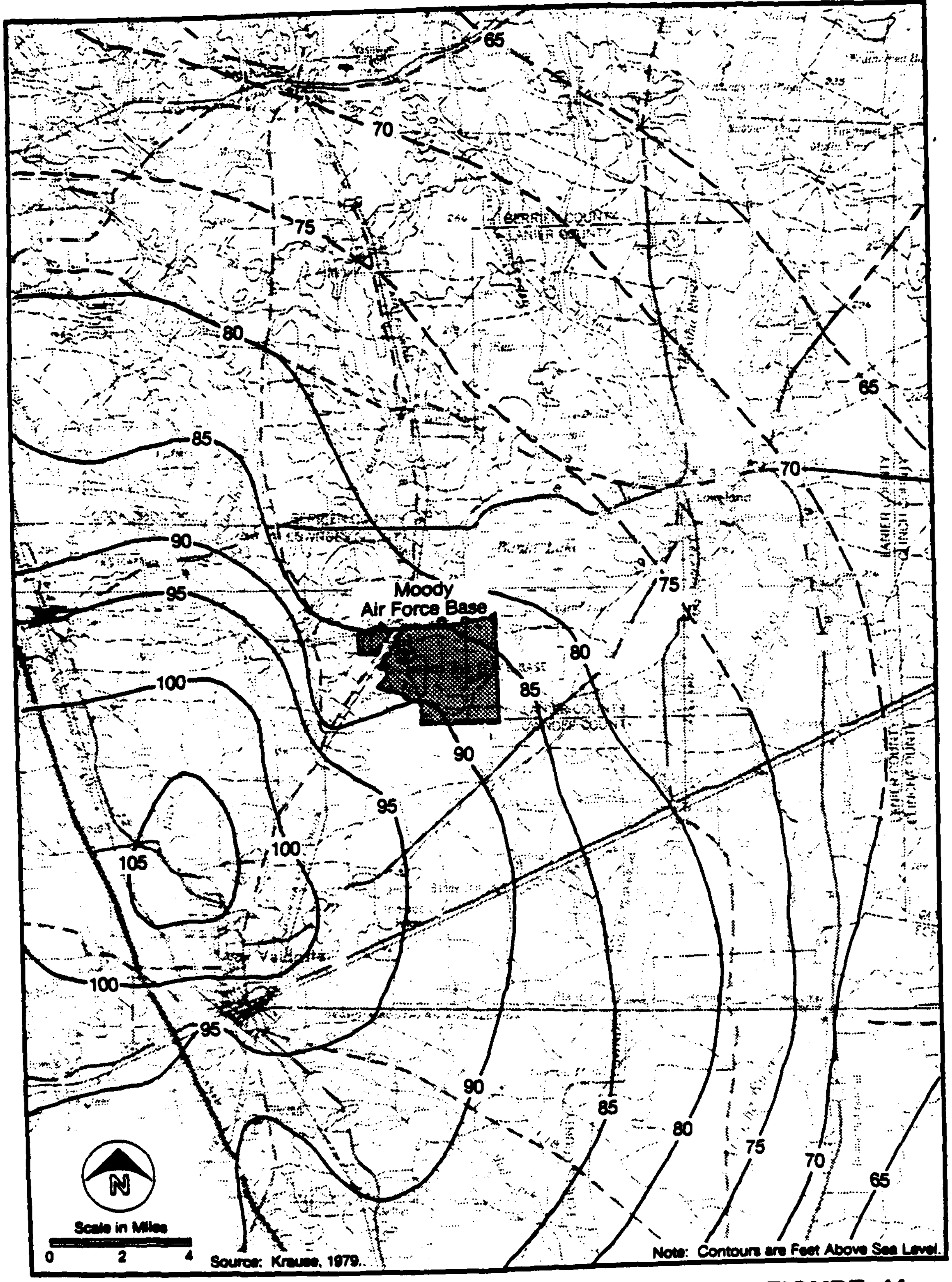



**FIGURE 11.**
Potentiometric Surface of the Principal Artesian Aquifer in the Vicinity of Moody AFB, Georgia, May 1975.

northeast. Most of the aquifer recharge occurs where the aquifer outcrops in central and southern Georgia, although some recharge occurs along a section of the Withlacoochee River 8 miles southwest of Moody AFB.

Groundwater withdrawals in the Valdosta, Georgia, area are causing water levels to decline in the principal artesian aquifer. Groundwater levels declined an average of 8.2 feet in downtown Valdosta between 1957 and 1975 with a minimum groundwater level of 143.50 feet bls recorded in 1968. A new record low groundwater level of 146.60 feet bls was set in 1981, and the minimum level recorded in 1985 was close to this record low.

Eleven active wells at Moody AFB have a combined capacity of approximately 2,700 gallons per minute (gpm). All of these wells withdraw water from the principal artesian aquifer. Although small to moderate amounts of water are available from the surficial aquifer, no known potable water supply wells penetrate this aquifer in the vicinity of the base. Available well construction details for the base wells are shown in Table 3 and some construction details for the three main water supply wells on base are shown in Figure 10. The locations of the base wells and other wells in the vicinity of Moody AFB are shown in Figure 12.

Water quality characteristics of the principal artesian aquifer in the vicinity of Moody AFB are summarized in Table 4. Wells 1, 2, and 3 supply 2.7 million gallons per day (mgd) of drinking water to the base. This water is treated at the base water treatment plant by aeration, chlorination, and fluoridation. No water quality problems have been reported with the base water supply, but naturally high concentrations of sulfate, hydrogen sulfide, iron, and color reportedly have been a problem in other wells in the area. Every three years, the base potable water supply wells are analyzed for organics, heavy metals, pesticides, and gross alpha radioactivity. Recent data indicate that primary drinking water standards are being met.

## 2.8 WASTE DISPOSAL AND STORAGE AREAS

Industrial operations have taken place at Moody AFB since the early 1940's, with a lapse in operations between 1945 and 1951. Major industrial operations have included pneudraulic, wheel and tire maintenance, aerospace ground equipment, corrosion control, and engine shops. As a result of these industrial activities, 25,000 to 50,000 gallons per year (gal/yr) of waste oils, fuels, solvents, and cleaners have been generated.

Of the spill and waste disposal sites at Moody AFB identified in Figure 3, the Southwest Landfill (Site 1) was

Table 3
WELL CONSTRUCTION DETAILS OF WATER WELLS AT MOODY AFB
AND GRASSY POND RECREATIONAL ANNEX

| Well No. | Location | Depth (feet) | Casing Size (inches) | Capacity (gpm) | Remarks |
|---|---|---|---|---|---|
| 1 | Building 913 | 425 | 10 | 625 | Potable--Main system |
| 2 | Building 946 | 425 | 12 | 625 | Potable--Main system |
| 3 | Building 984 | 440 | 10 | 630 | Potable--Main system |
| 4 | 100 feet north of Building 205 | 345 | 6 | 250 | Non-potable, air conditioning, currently not in use |
| 5 | Building 1116--Ordnance Area | 250 | 6 | 180 | Non-potable, fire protection |
| 5A | 40 feet west of Building 1112 | 150 | 6 | 100 | Potable--Ordinance area |
| 6 | Building 1702--Former Jet Engine Test Cell | 210 | 4 | 19 | Non-potable--Fire protection |
| 7 | Building 1705--Mission Lake Recreation Area | 195 | 4 | 10 | Potable--Mission Lake Recreation Area |
| 8 | Golf Course | 400 | 6 | 220 | Non-potable--Golf course irrigation |
| 9 | Grassy Pond Recreational Annex | -- | 4 | -- | Potable |
| 10 | Grassy Pond Recreational Annex | -- | 2 | -- | Potable |
| 11 | Grassy Pond Recreational Annex | -- | 10 | -- | Irrigation supply |
| 12 | Building 1500--Transmitter Site | 215 | 4 | 12 | Potable--Transmitter site |
| 13 | Building 1501--Receiver Site | 225 | 4 | 12 | Potable--Receiver site |

Note: Well Nos. 9, 10, and 11 are located at Grassy Pond.
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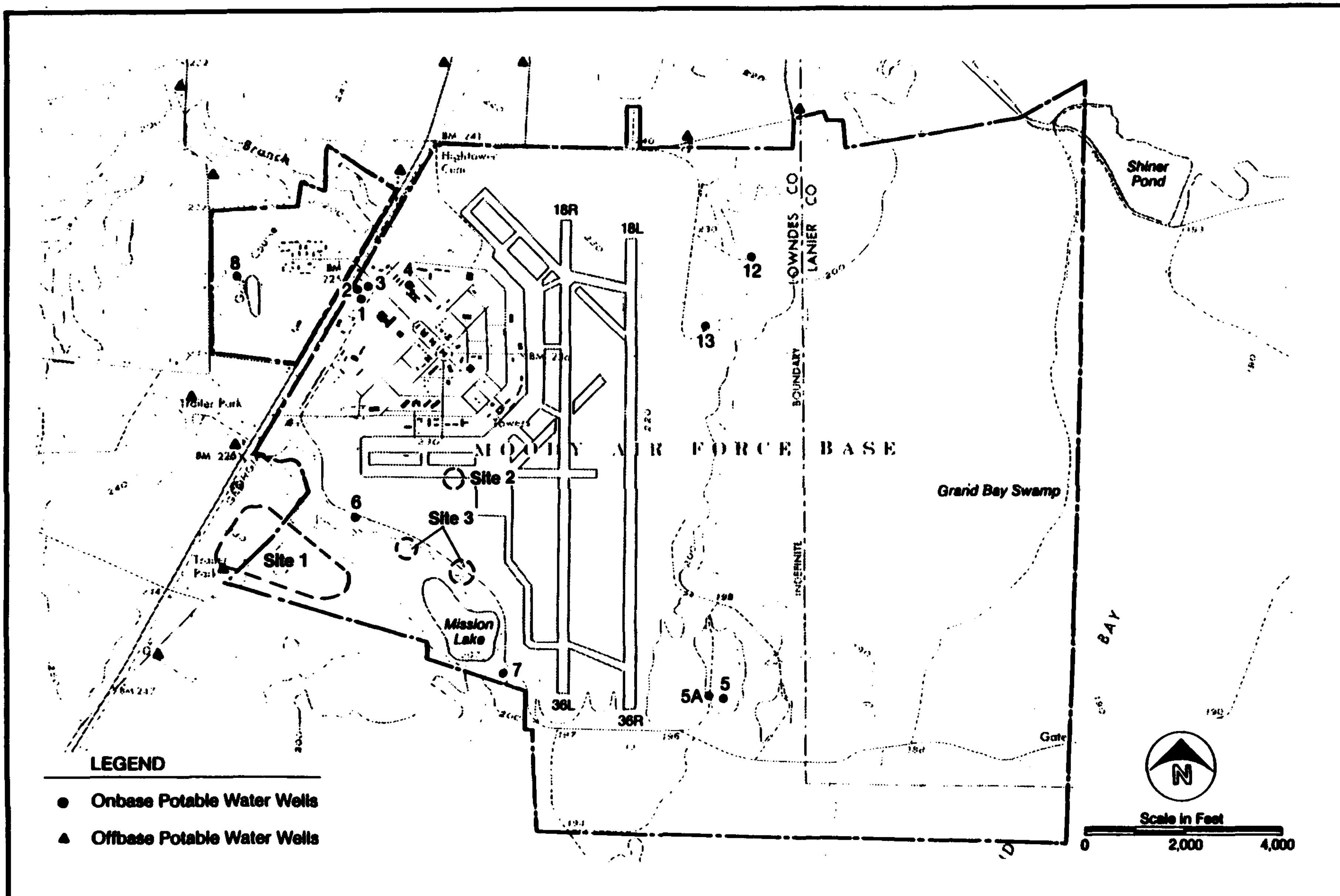


FIGURE 12.
Location Map of Water Supply Wells, Moody AFB, Georgia.

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Table 4
WATER QUALITY CHARACTERISTICS OF THE PRINCIPAL
ARTESIAN AQUIFER IN THE VICINITY OF MOODY AFB, GEORGIA

| Parameter[a] | Average for Lowndes County[b] | Base Wells[c] No. 1 | No. 2 | No. 3 | EPA and Georgia Drinking Water Standards |
|---|---|---|---|---|---|
| Arsenic | .005 | <.01 | <.01 | <.01 | .05 |
| Cadmium | .002 | <.01 | <.01 | <.01 | .01 |
| Chromium | .001 | <.05 | <.05 | <.05 | .05 |
| Copper | .002 | -- | -- | -- | 1.0 |
| Lead | .003 | <.02 | <.02 | <.02 | .05 |
| Mercury | .0001 | <.002 | <.002 | <.002 | .002 |
| Selenium | .004 | <.01 | <.01 | <.01 | .01 |
| Strontium | .086 | -- | -- | -- | 5.0 |
| Zinc | .021 | <.05 | <.05 | <.05 | 5.0 |
| Silica as $SiO_2$ | 27 | 37.6 | 36.0 | 33.2 | -- |
| Aluminum | .026 | -- | -- | -- | -- |
| Iron | .028 | 0.1 | <0.1 | 0.147 | 0.3 |
| Manganese | .015 | <.05 | <.05 | <.05 | .05 |
| Calcium | 33 | 24.6 | 25.8 | 28.6 | -- |
| Magnesium | 8.6 | 10.2 | 9.8 | 10.0 | -- |
| Sodium | 3.5 | 2.9 | 2.8 | 2.7 | -- |
| Potassium | 0.7 | 0.8 | -- | -- | -- |
| Alkalinity as $CaCO_3$ | 105 | 108 | 108 | 110 | -- |
| Hardness as $CaCO_3$ | 119 | 103 | 105 | 113 | -- |
| Sulfate as $SO_4$ | 14 | 17 | 20 | 27 | 250 |
| Chloride | 3.6 | 4 | <1 | <1 | 250 |
| Fluoride | 0.3 | -- | -- | -- | 1.6 |
| Nitrate | 0.3 | <0.1 | <0.1 | <0.1 | 10 |
| Dissolved Solids | 165 | 158 | 196 | 192 | 500 |
| Specific Conductance (µmhos/cm) | 244 | -- | -- | -- | -- |
| Color (platinum-cobalt blue) | 10 | 5 | 5 | 15 | 15 |

Source: Krause 1979, and USAF OEHL.

[a]Parameters are in mg/l unless otherwise indicated.

[b]Sampled 1974-1975.

[c]Sampled January 1982.

selected for further consideration in this study. Three other sites not shown in Figure 3 were included for Phase II study: the underground waste fuel storage area (Site No. 2), the flightline storm drain outfall (Site No. 3), and Moody AFB Supply Well 10 at the Grassy Pond Annex (Site No. 4). These sites were shown in Figures 1 and 2.

### 2.8.1 SITE 1. SOUTHWEST LANDFILL

The Southwest Landfill (Site 1), shown in Figure 13, covers approximately 30 acres in the southwest corner of Moody AFB, west of Mission Lake. Of the base landfills, this site was operated the longest and was reportedly in use from 1955 to 1972. General base refuse was deposited in trenches approximately 14 feet deep. During the 1950's, a small amount of low-level radioactive waste was reportedly buried here. Small quantities of waste solvent, hydraulic fluid, and paint wastes were placed in this landfill before 1975. Approximately once every three years, about 50 gallons of residue from cleaning the active underground fuel storage tanks was taken to Site 1 and allowed to weather. Stabilized and dewatered sludge from the base wastewater treatment plant has been mixed with mulch and composted in a one- to two-acre area at this site since about 1977. Some organic debris is also now disposed of at Site 1. There are no reports of disposal of large quantities of hazardous wastes, such as unused pesticides, in the Southwest Landfill.

Interceptor ditches used for runoff and leachate collection at the Southwest Landfill are still visible. These ditches eventually drain into Mission Lake, but no contamination appears to be present. Relatively high groundwater levels in the area make the water table aquifer susceptible to contamination by any leachate generated.

### 2.8.2 SITE 2. UNDERGROUND WASTE FUEL STORAGE AREA

Site 2, the underground waste fuel storage area, shown in Figure 14, is located on an abandoned runway near Building 795. According to base records, the area was historically known as Aircraft Tank Farm Facility No. 4147. A 5,000-gallon steel tank for storage of waste fuels had been in use since 1976 and was operated by the Fuels Management Branch. Contaminated fuels from the flightline were collected in this tank and tested before being filtered and reused in aircraft or ground equipment. Record drawings dated July 1984 obtained from base civil engineering personnel indicate that the tank was to have been abandoned in-place. Base personnel indicate that the tank was actually removed from service and excavated, probably in mid to late 1984.

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**FIGURE 13.**
Location Map—Site 1, Southwest Landfill, Moody AFB, Georgia.

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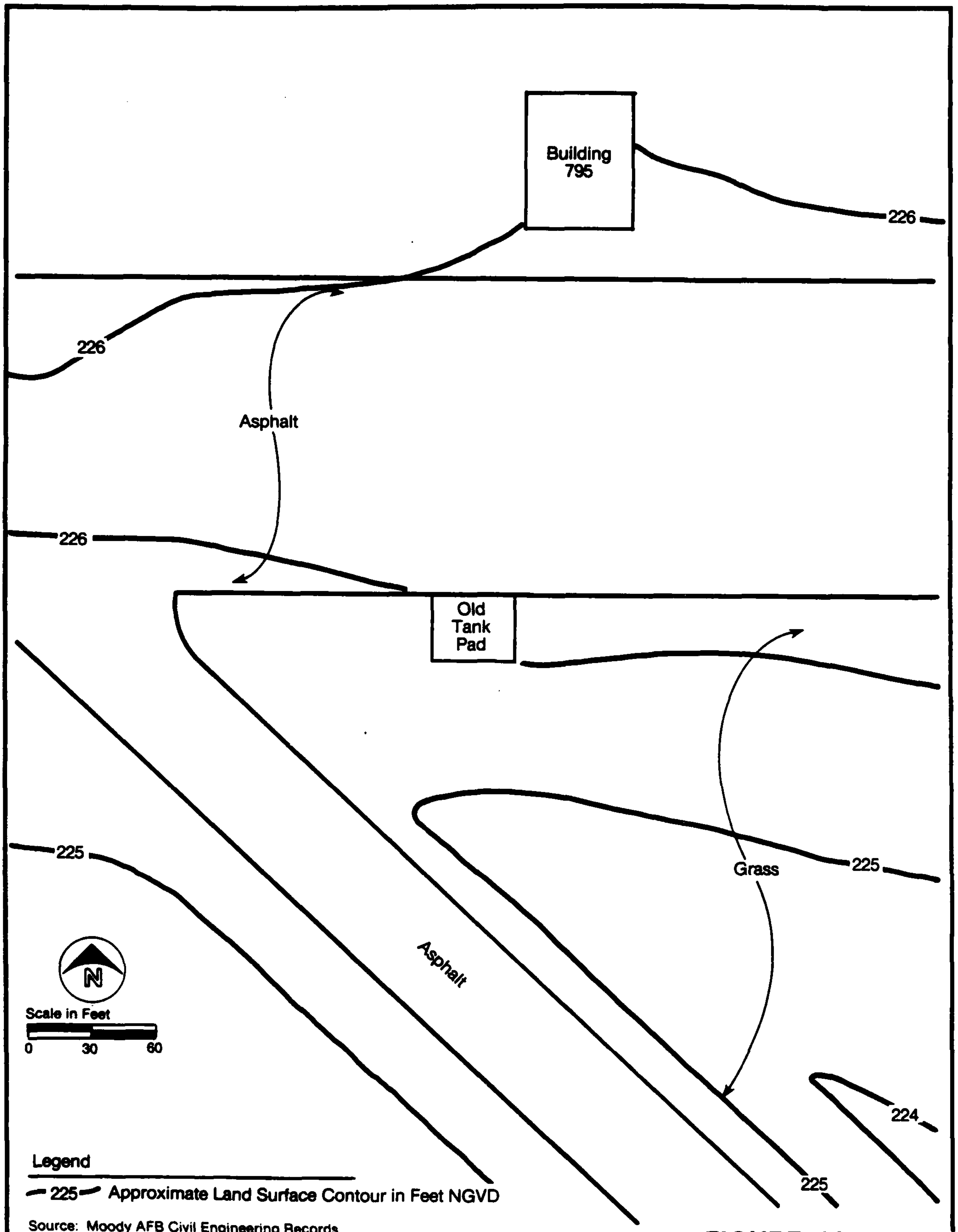


**FIGURE 14.**
Location Map—Site 2, Underground Waste Fuel Storage Area, Moody AFB, Georgia.

### 2.8.3 SITE 3. FLIGHTLINE STORM DRAIN OUTFALL

The flightline storm drain outfall (Site 3) is shown in Figure 15. Drainage from the ramp areas of the base near the maintenance areas enters this storm drain and discharges into Mission Lake, in the southwestern part of the base. From 1941 to 1946 and 1951 to 1955, waste solvents and small quantities of waste oils and hydraulic fluids were reportedly washed down the storm drain leading to Mission Lake. Rinsewater, alkaline solution, potassium permanganate, and nitric acid in 600- to 800-gallon vats were used for parts cleaning on the base. Although it was not standard practice, before 1975 these vats were occasionally emptied into the storm drain. In 1972 or 1973, the seal on the permanganate tank reportedly broke, releasing the tank contents into the storm drain and turning Mission Lake purple. Smaller 50- to 100-gallon vats containing PD 680 and trichloroethene (TCE) were also used before 1975 and occasionally overflowed into the storm drain system which emptied into Mission Lake. Before 1977, approximately 2,000 gal/yr of PD 680 and 660 gal/yr of aircraft cleaning compound, TCE, oils and greases, and jet fuel from the washrack drained into the storm drain. All industrial shop wastewater discharges were connected to the sanitary sewer system in 1975.

During the early 1970's, samples were routinely collected from seventeen stormwater drain and drainage ditch sampling points on the base. After the industrial shops were connected to the sanitary sewer system in 1975, only two sampling points were monitored, including the flightline storm drain. During the early 1970's, analyses were made for heavy metals, phenols, oils and grease, COD, total organic carbon (TOC), suspended solids (SS), ammonia nitrogen, nitrate nitrogen, and total Kjeldahl nitrogen. Chemical oxygen demand, oil, and grease were periodically elevated in the flightline area drainage, but heavy metals were generally low. The flightline storm drain and petroleum, oil and lubricants (POL) storm drain are now routinely sampled for oil and grease, COD, and SS. Available data collected from the flightline storm drain are summarized in Table 5.

Water quality in the Site No. 3 area may have been affected by past fire training activities. The Burma Road Fire Department Training Area, directly southeast of Mission Lake, was used for fire department training exercises from 1941 to 1946 and 1951 to 1955. Most of the base industrial wastes were stored at the site in 55-gallon drums and then burned during these exercises. Fire training activities were generally conducted on a weekly basis between 1951 and 1955, using 300 to 1,000 gallons of waste for each exercise. The wastes were burned in a circular bermed pit area and the fires were put out with protein foam and water. Most of the

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**FIGURE 15.**
Location Map—Site 3, Flightline Storm Drain Outfall, Moody AFB, Georgia.

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Table 5
FLIGHTLINE STORM DRAIN OUTFALL MONITORING SUMMARY (1977-1981)
MOODY AFB, GEORGIA

| Parameter | 1977 Average | 1978 Average | 1979 Average | 1980 Average | 1981 Average |
|---|---|---|---|---|---|
| COD, mg/l | 22.3 | 27.5 | 18.3 | 11.4[a] | 20.0 |
| Oils and Grease, mg/l | 0.5 | 0.3 | 0.3 | 0.3[a] | 0.3 |
| Residue Non-Filterable (SS) mg/l | 9.3 | 10.7 | 7.8 | 29.9[a] | 4.3[b] |

[a]Sampling accomplished January to August 1980.

[b]Sampling accomplished February, March, and May 1981.

wastes were probably consumed in the fires, but some percolation of the wastes into the ground may have occurred. This bermed area probably also collected rainfall, which may have enhanced migration of burn residues into the groundwater. The wastes used for fire training at this site included the following:

- Approximately 1,000 to 1,300 gal/yr of engine oils, grease, antifreeze, and hydraulic fluids from the vehicle maintenance shop.
- Approximately 3,320 gal/yr of waste hydraulic fluid, engine oil, and PD 680 from the aerospace ground equipment shop.
- Approximately 1,760 gal/yr of paint stripper, PD 680, and hydraulic fluid from the phase docks and wheel and tire shops.
- Approximately 440 gal/yr of contaminated JP-4 fuel.
- Paint wastes.
- Paint thinners.

A landfill in the Site 3 area also may have affected the local water quality. The Burma Road Landfill was in use from 1941 to 1946 and from approximately 1951 to 1955. This landfill site is near the Burma Road Fire Department Training Area, approximately 800 feet southeast of Mission Lake. General refuse such as garbage, paper, lumber, and metal was reportedly placed in this landfill. Small amounts of hazardous materials, including contained waste paint products, may also have been disposed of at this landfill.

Mission Lake receives the flightline storm drain runoff and is close to the Southwest Landfill. A comprehensive set of water quality data for the lake collected in March 1976 included heavy metals, cyanide, phenols, oil and grease, COD, TOC, nitrate nitrogen, ammonia nitrogen, and total Kjeldahl nitrogen analyses. Heavy metals were generally absent except for a total chromium concentration of 0.2 mg/l and hexavalent chromium concentration of 0.1 mg/l. In general, the water quality appeared to be good, although fish kills have occurred at the lake in the past. The fish kills were reportedly caused by oxygen depletion from eutrophication and treatment of the lake with algicides. Komeen is currently used for algae control in Mission Lake.

Historical water quality data for Moody AFB Well No. 7, near Mission Lake, are shown in Table 6. No VOC's or pesticides were ever detected in this well. In September 1985, a COD of 30 mg/l and a TOX concentration of 22 μg/l were

Table 6
HISTORICAL WATER QUALITY DATA--WATER SUPPLY WELLS
MOODY AFB, GEORGIA

| Parameter Detected | Well No. 7 Misson Lake | | | Well No. 10 Grassy Pond Annex | | |
|---|---|---|---|---|---|---|
| | 1/8/85 | 1/28/85 | 9/16/85 | 1/8/85 | 1/28/85 | 2/5/85 |
| **CONVENTIONAL (mg/1)** | | | | | | |
| Alkalinity | 120 | 120 | 121 | 90 | 95 | NA |
| Calcium | 22.5 | 22.7 | 22.6 | 27.8 | 22.5 | NA |
| Chloride | 4 | NA | NA | 24 | NA | NA |
| Hardness | 113 | 109 | 112 | 83 | 67 | NA |
| Iron | BMDL | BMDL | NA | 0.773 | 0.194 | NA |
| Magnesium | 13.7 | 12.8 | 13.6 | 3.2 | 2.7 | NA |
| Nitrate | 2.1 | BMDL | NA | BMDL | BMDL | NA |
| Sodium | 4.3 | 4.2 | NA | 5.5 | 2.7 | NA |
| Sulfate | 6 | 11 | 8 | 4 | 20 | NA |
| Total Dissolved Solids | 193 | 125 | NA | 171 | 101 | NA |
| **METALS (µg/1)** | | | | | | |
| Copper | BMDL | BMDL | NA | 36 | BMDL | NA |
| Zinc | 202 | BMDL | NA | NA | 533 | NA |
| CHEMICAL OXYGEN DEMAND (mg/1) | NA | NA | 30 | NA | NA | NA |
| TOTAL ORGANIC HALOGENS (µg/1) | NA | NA | 22 | NA | NA | NA |
| **ORGANICS (µg/1)** | | | | | | |
| Chloroform | NA | NA | BMDL | NA | NA | 158.9 |
| Bromodichloromethane | NA | NA | BMDL | NA | NA | 6.7 |
| Total THM | NA | NA | BMDL | NA | NA | 165.6 |
| VOC's (EPA Method 601/602) | NA | NA | BMDL | NA | NA | NA |
| **PESTICIDES (µg/1)** | | | | | | |
| Drinking Water List | NA | BMDL | NA | BMDL | BMDL | NA |
| 2, 4-D | BMDL | BMDL | NA | BMDL | BMDL | NA |
| 2, 4, 5-T | BMDL | BMDL | NA | BMDL | BMDL | NA |
| Silvex | BMDL | BMDL | NA | BMDL | BMDL | NA |

BMDL-Below Method Detection Limit
NA-Not analyzed

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measured in Well No. 7. These parameters were not analyzed for previously in that well. The TOX concentration could indicate the presence of halogenated organics in the groundwater; however, this relatively low concentration could be attributed to positive interferences from color or naturally occurring organics. Tannic acids, humic acids, and other naturally occurring non-halogenated organics can cause positive interferences in TOX analyses. Low TOX concentrations could be the result of these interferences. A COD concentration of 30 mg/l is relatively high and may indicate the presence of organic pollutants, even though no VOC's were detected in the groundwater.

Zinc was detected in Well No. 7 on January 8, 1985, at a concentration of 0.202 mg/l, well below the secondary drinking water standard of 5 mg/l. No other metals were ever detected in Well No. 7. Conventional parameters measured in this well were all close to the average levels reported for the principal artesian aquifer in Lowndes County (see Table 4).

### 2.8.4 SITE 4. MOODY AFB SUPPLY WELL 10 AT GRASSY POND ANNEX

The Grassy Pond Annex, previously described in Section 1.4.4 and shown in Figure 2, is used for recreational activities by base personnel. Moody AFB Supply Well No. 10 is located at the Grassy Pond Annex. This 140-foot-deep, two-inch-diameter well is used for backup of the potable water supply at the recreational area.

Several factors at the Grassy Pond Annex could lead to contamination of the water supply wells. Pesticides used in 1982 (Diquat and 2,4-D) to control water hyacinths in the two ponds, septic tanks and drainage fields used for sanitary waste disposal, and a small landfill area currently used for organic debris disposal and previously used for domestic refuse disposal are among these potential hazards.

Historical water quality data for Well No. 10 are shown in Table 6. In February 1985, a total trihalomethane (THM) concentration of 165.6 µg/l was measured in this well. This value exceeds the primary drinking water maximum contaminant level (MCL) of 100 µg/l. The two THM's detected were chloroform (158.9 µg/l) and bromodichloromethane (6.7 µg/l). A standard EPA Method 601/602 analysis for priority pollutant VOC's was not run for this well, but scans for particular pesticides which have drinking water MCL's did not detect any pesticide contamination of the groundwater at this site.

A concentration of 0.533 mg/l zinc was detected in Well No. 10 the only time this parameter was analyzed for on

January 28, 1985. This concentration is well below the secondary drinking water standard of 5 mg/l. Copper was detected on January 8, 1985, at a concentration of 0.036 mg/l, well below the secondary drinking water standard of 1 mg/l. No other metals were ever detected. Conventional parameters measured in this well were all close to average levels reported for the principal artesian aquifer in Lowndes County (see Table 4).

## Section 3
## FIELD PROGRAM

### 3.1 FIELD PROGRAM DEVELOPMENT

Detailed planning efforts concerning the execution and control of field work activities required by the Phase II Scope of Work (SOW) were conducted during September-November 1986. The bulk of these efforts culminated in the preparation of a detailed work plan and description of activities, as contained in the October 1986 Technical Operations Plan (TOP) in Appendix E. The major planning-related components of the field program are summarized below.

#### 3.1.1 TOP PREPARATION

This component involved the cumulative effort of the project manager, project hydrogeologist, laboratory manager/site safety coordinator and senior project personnel. These team members developed detailed procedures for use in conducting the field program and in preparing the data for presentation in the Peer Review Draft report of investigations. The major categories used in this respect are developed in detail as Sections 4.0-14.0 and Appendix A of the TOP.

#### 3.1.2 SUBCONTRACTOR SELECTION

This component involved preparation of bid specifications for the drilling, boring and monitor well installation portion of the field program; solicitation of bids from qualified companies; evaluation of bids; bid award; and subcontract finalization. The project was awarded to Liberty Drilling, Testing and Boring, Inc. located in Ocala, Florida, and subcontracts were completed in early November. Section 3.3 of the TOP addresses the subcontractor component of the program in more detail.

#### 3.1.3 TRAINING

This component involved briefings of project team members regarding the overall objectives of the project, the requirements of the SOW, Site Safety Plan and TOP, and their respective tasks. Team members were provided a copy of the SOW, TOP, and Site Safety Plan in addition to written instructions regarding their specific assignment, the man-hours allocated to the tasks assigned, and pertinent reporting and administrative procedures.

### 3.1.4 COORDINATION

The project hydrogeologist coordinated with base personnel and the program manager to ensure that the field program could begin promptly and proceed as smoothly as practical. It included a November 12 onsite meeting to resolve specific needs for base information or assistance, as outlined in Section 3.1 of the TOP. It also included the November 12-13 location of all boring and monitor well installations and sampling stations (with the concurrence of the program manager). In addition to site reviews, the subcontractor mobilized equipment during this period and was instructed as to site access procedures, decontamination areas, and equipment storage areas.

The project hydrogeologist and senior hydrologist conducted periodic onsite observations of the program work tasks. The project hydrogeologist was also onsite as necessary to orient various field program crews to base procedures, site locations, and sampling points.

## 3.2 FIELD PROGRAM IMPLEMENTATION

The field program conducted for this study consisted of three general categories of tasks: drilling, boring, and monitor well installations; water quality sampling; and testing. Activities involved with each task are outlined below. All of these activities were carried out at Sites 1 and 2; however, only sampling activities were conducted at Sites 3 and 4. Results from these tasks are presented and evaluated in Section 4. Appropriate sections of the TOP are cross-referenced where continuity or clarity are not sacrificed.

### 3.2.1 DRILLING, BORING AND WELL INSTALLATIONS

Following a one-week delay to accommodate base training exercises, this field program task commenced on November 17, 1986. Pursuant to requirements of the TOP and request for bids, the subcontractor deployed a drilling rig and crew (mobilized to the base during the previous week) to both Sites 1 and 2. The approach was to dedicate a large rig (i.e., Speedstar® 15-S) to complete deep borings and monitor well installations at Site 1. A smaller trailer-mounted rig (i.e., Deep Rock RAM®) was to install temporary well points and perform the required standard penetration test at Site 2. Then, shallow borings and monitor well installations would be completed at both sites. A CH2M HILL field hydrogeologist was assigned to each rig to oversee geotechnical operations, conduct required sampling and monitoring, and document well construction completion. As a result of persistent rainy weather and drilling difficulties

encountered, completion of the task was extended until November 26, 1986.

Deep monitor well installations were accomplished in accordance with the TOP using hollow stem augers. Since the boreholes were found to remain open, and the presence of a relatively deep initial water table and a dense shallow hardpan in some areas, a field decision was made to utilize small diameter solid stem augers for installing temporary well points and shallow monitor wells. The required Standard Penetration Test (SPT) boring at Site 2 was accomplished pursuant to ASTM D-1586. Split-spoon samples of subsurface layers were generally obtained at 5-foot intervals in all monitor well boreholes. The field hydrogeologists were responsible for logging samples obtained and for monitoring ambient conditions (e.g., organic vapor levels) during drilling. Downhole drilling tools used for monitor well installations were decontaminated before the start of work and between installations to minimize potential for cross-contaminating boreholes. These field activities were conducted in accordance with the following detailed procedures:

- o Routine subsurface sampling and monitor well construction per TOP Sections 8.2 and 8.2.1.
- o Installing temporary well points per TOP Section 8.2.2.
- o Conducting the SPT boring per TOP Section 8.2.3.
- o Decontamination procedures for boring, drilling, and well installation work per TOP Section 11.1 and 11.2.

The field hydrogeologists determined that containing cuttings from the borings in 55-gallon drums was not required because visual observations and organic vapor levels did not indicate the cuttings were potentially hazardous (see TOP Section 8.2.1). Cuttings from the boreholes were left near the location where they originated. Objectives for the subcontractor in performing site cleanup are outlined in TOP Section 14.0.

#### 3.2.1.1 Site 1. SOUTHWEST LANDFILL

Six shallow and three deep monitor wells were installed and developed at Site 1. The monitor well locations are shown in Figure 16 and well construction details are summarized in Table 7. Two deep wells (L-13D and L-15D) are paired with two existing shallow wells (L-2 and L-1, respectively). Final well construction diagrams and the detailed soil boring logs for the Site 1 monitor well installations are presented in Appendix D. As indicated, the shallow wells were finished approximately 30 feet bls and the deep wells


LEGEND

- ▲ Existing Monitor Wells- Location of Well L-3 is Approximate
- ● New Monitor Wells
- ◉ Deep Water Supply Well

Scale in Feet

0 200 400

N

A-A' Geologic Cross-Section (see Figure 20)

B-B' Geologic Cross-Section (see Figure 21)

Approximate M

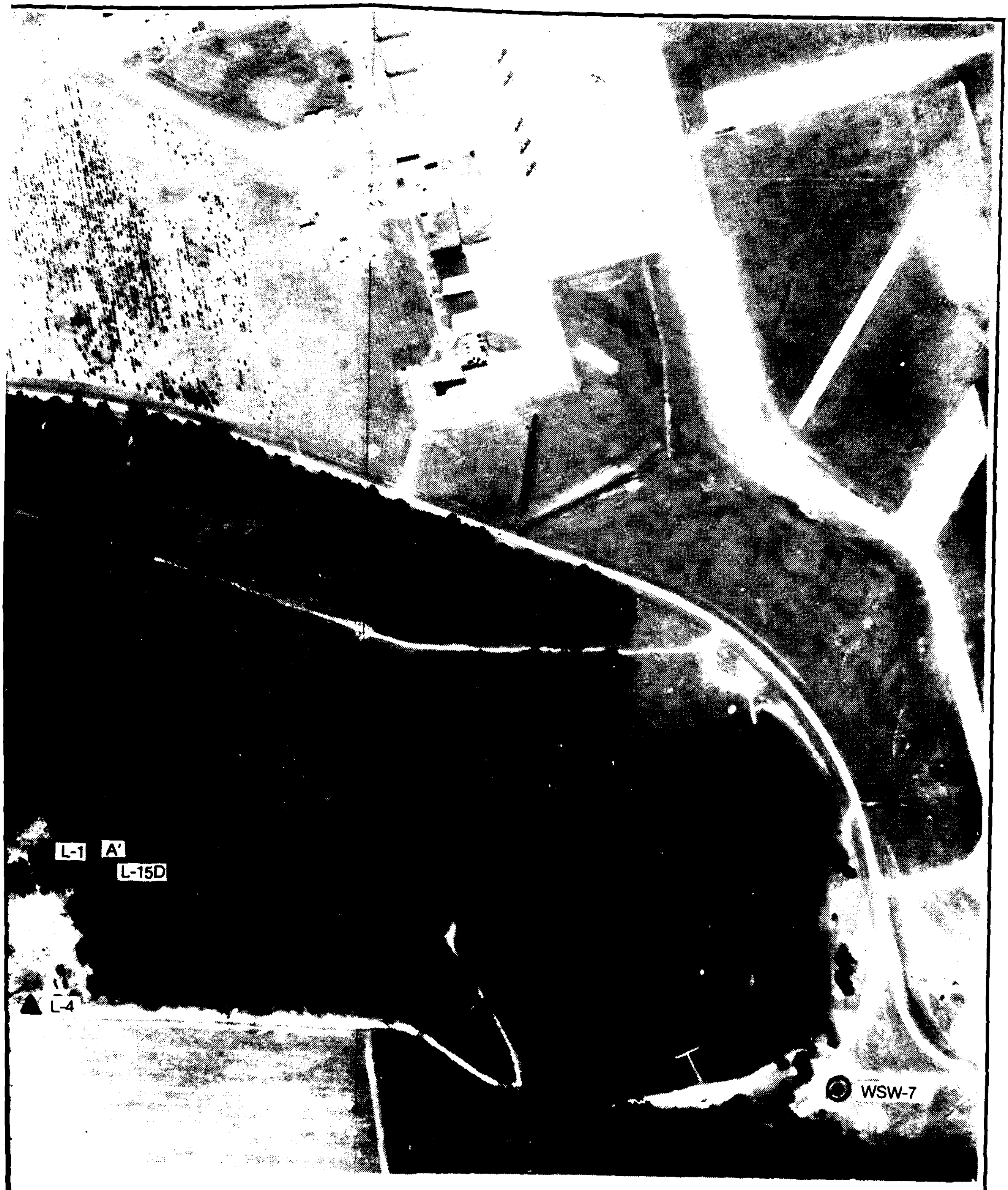


**FIGURE 16.**
imate Monitor Well Locations, Site 1, Southwest Landfill, Moody AFB, Georgia.

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Table 7
SUMMARY OF MONITOR WELL CONSTRUCTION DETAILS[a]
SITES 1 AND 2, SOUTHWEST LANDFILL AND
UNDERGROUND WASTE FUEL STORAGE AREA
MOODY AFB, GEORGIA

| Site | Well Designation | Approx. Well Depth (ft)[b] | Est. Depth Below Land Surface (ft)[b] Top of Screen | Est. Depth Below Land Surface (ft)[b] Bottom of Screen | Top of Casing Elevation (Ft-NGVD)[c] |
|---|---|---|---|---|---|
| 1 | L-7S | 30 | -20 | -30 | 230.06 |
| 1 | L-8S | 30 | -20 | -30 | 222.77 |
| 1 | L-9S | 28 | -18 | -28 | 219.66 |
| 1 | L-10S | 30 | -20 | -30 | 220.40 |
| 1 | L-11S | 30 | -20 | -30 | 222.31 |
| 1 | L-12S | 30 | -20 | -30 | 222.63 |
| 1 | L-13D | 77 | -67 | -77 | 223.85 |
| 1 | L-14D | 80 | -70 | -80 | 222.31 |
| 1 | L-15D | 80 | -70 | -80 | 219.14 |
| 2 | MU-1 | 30 | -20 | -30 | 225.44 |
| 2 | MU-2 | 30 | -20 | -30 | 224.90 |
| 2 | MU-3 | 30 | -20 | -30 | 225.68 |
| 2 | MU-4 | 30 | -20 | -30 | 226.04 |

[a] Wells were constructed November 1986 by Liberty Drilling, Testing, and Boring (Ocala, Florida). All wells were constructed of 2-inch Schedule 80 PVC casing and screens, with 0.010-inch slots and 20-30 silica sand backfill.

[b] Refer to the final monitor well construction diagrams for more details.

[c] Elevation established by CH2M HILL on the north side of casing.

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were completed at the top of the primary clay confining zone which occurred at approximately 80 feet bls. All wells were screened over the bottom 10 feet of depth.

#### 3.2.1.2 Site 2. UNDERGROUND WASTE FUEL STORAGE AREA

At Site 2, ten locations were originally planned for temporary well point installations, each with a maximum depth of 20 feet bls. The well points were used to assess the extent of free JP-4 hydrocarbon contamination in the shallow groundwater at the site, which may have resulted from past underground fuel tank leakage. Upon installation of the first well point, it became apparent that deeper boreholes would be necessary to penetrate shallow groundwater, which appeared to be present under semi-confined conditions. The program manager was advised of conditions at the site on November 17, who determined that the total depth of well point boreholes (i.e., 200 linear feet) allowable under the SOW should not be exceeded. As a result, professional field judgment was used in deleting the appropriate boreholes to accommodate the total footage limitation.

Seven temporary well points were installed during November 17-18 at the locations indicated in Figure 17. Individual borehole depths ranged from 25 to 30 feet bls, and the cumulative depth totaled 199 feet. Boreholes were backfilled with clean silica sand to about 20 feet bls. Two-inch PVC well points were placed into the boreholes and were screened from approximately 12 to 20 feet bls. Clayey soils from the borehole cuttings were packed around the capped casing riser to minimize the passage of water from heavy rainfall and stormwater runoff into the borehole.

Four sets of measurements for water levels, organic vapor levels, and free floating JP-4 product were made from the well points during November 19-24. Elevations of the top of the well point casings were measured on November 19 based on a temporary benchmark of arbitrary elevation. To assure that the shallow groundwater level (and any floating product) was within screened intervals, the well points were manually raised and re-surveyed on November 20. Summary tables of free product and organic vapor measurements are presented in Appendix D.

The location for the SPT boring was selected using information obtained from the well points. As indicated in Figure 17, the location was adjacent to Well Point No. 5 where the highest levels of contamination were indicated. Split-spoon samples were obtained continuously during the 20-foot-deep boring conducted on November 24. Four samples were selected from the subsurface profile to be analyzed for aromatic hydrocarbon and petroleum hydrocarbon content. As

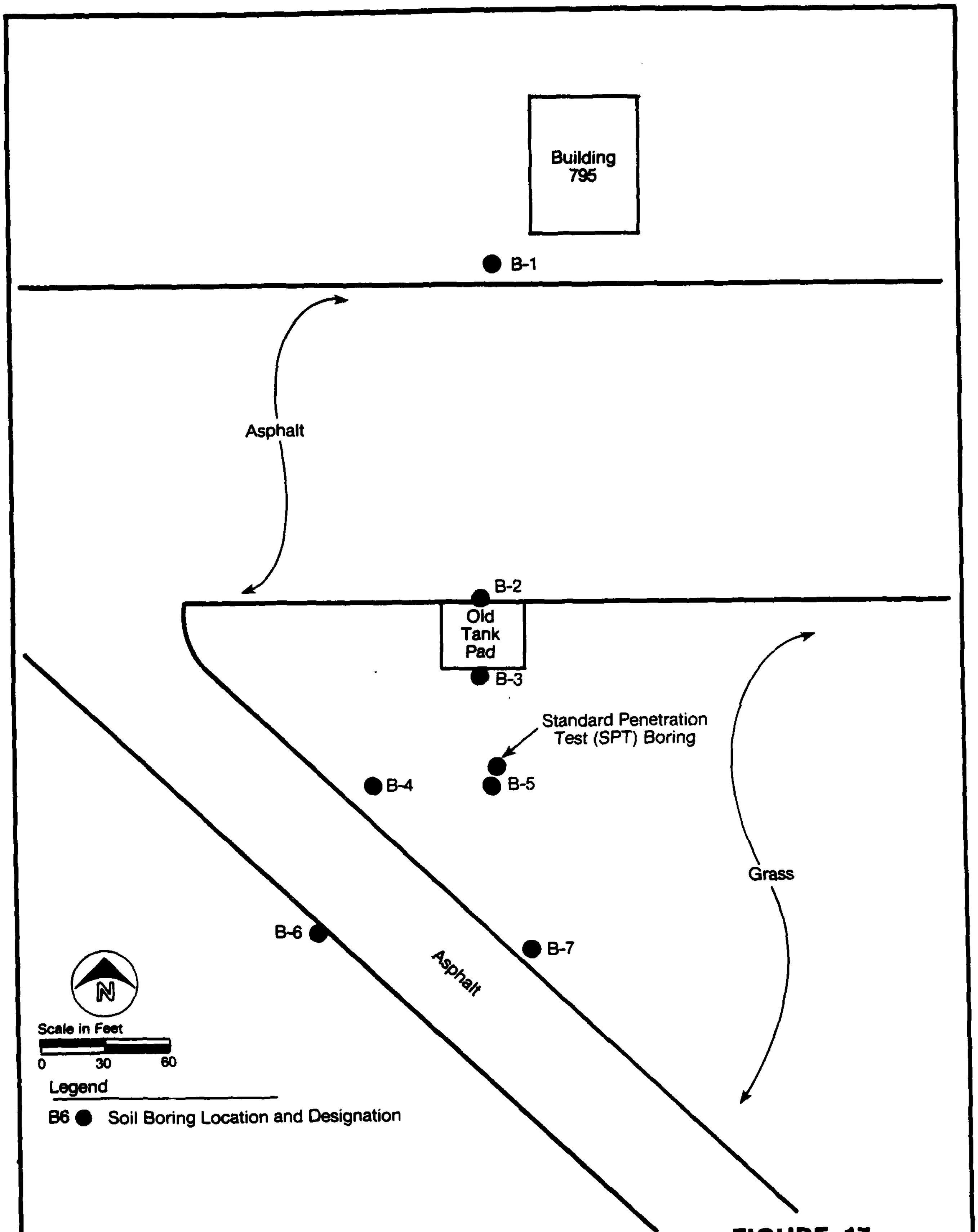


**FIGURE 17.**
**Approximate Temporary Well Point and SPT Boring Locations, Site 2, Underground Waste Fuel Storage Area, Moody AFB, Georgia.**

addressed in TOP Section 10.4.3, samples were selected from the middle of the sample core on the basis of organic vapor levels and observations. The detailed log for the SPT boring is shown in Appendix D.

While the SPT boring was being conducted, temporary well points were removed. Boreholes were grouted from bottom to top. Reinforcing steel bar (rebar) sections were placed in the center of the grouted boreholes to mark the location permanently.

The temporary well point information was also used to locate four shallow monitor wells during November 24-25, 1986. The intent was to locate one well hydraulically upgradient of the old tank area, two wells at the downgradient edge of the estimated zone of dissolved hydrocarbon contamination, and one well downgradient from this zone. The locations of the four wells are shown in Figure 18 and the construction details are presented in Table 7. Well MU-2 was completed in the borehole created by the SPT boring. Final well construction diagrams and detailed soil boring logs for the Site 2 monitor well installations are presented in Appendix D. As indicated, all wells were finished approximately 30 feet bls and were screened over the bottom 10 feet of depth.

3.2.1.3 Problems

In addition to problems caused by inclement weather and resulting drilling difficulties, other problems were encountered during this task. For example, location of the existing monitor wells at Site 1, wells L-2 and L-3, was difficult. No base personnel had ever been to the locations. During the initial site reconnaissance with the program manager and subcontractor, the well thought at that time to be existing Well L-2 was not found. Following completion of the site survey task, it was discovered that existing Well L-3 was the one not located. New monitor wells were located as accessibility permitted.

Upon reaching final depth at Well L-15D at Site 1, smaller augers were used for cleaning out the bottom segment of the hollow stem of the seated augers. The smaller augers became locked into the formation and the only way to retrieve them was to totally withdraw the seated outer augers and re-auger the borehole. Also, during cementing of the well casing, a relatively porous sandy zone encountered approximately 30 feet bls accepted a considerable amount of grout. This required a phased approach in completion of the grouting, allowing for overnight setup of the first grout phase.

All boreholes and monitor wells were completed at the D level of safety pursuant to the Site Safety Plan. However,

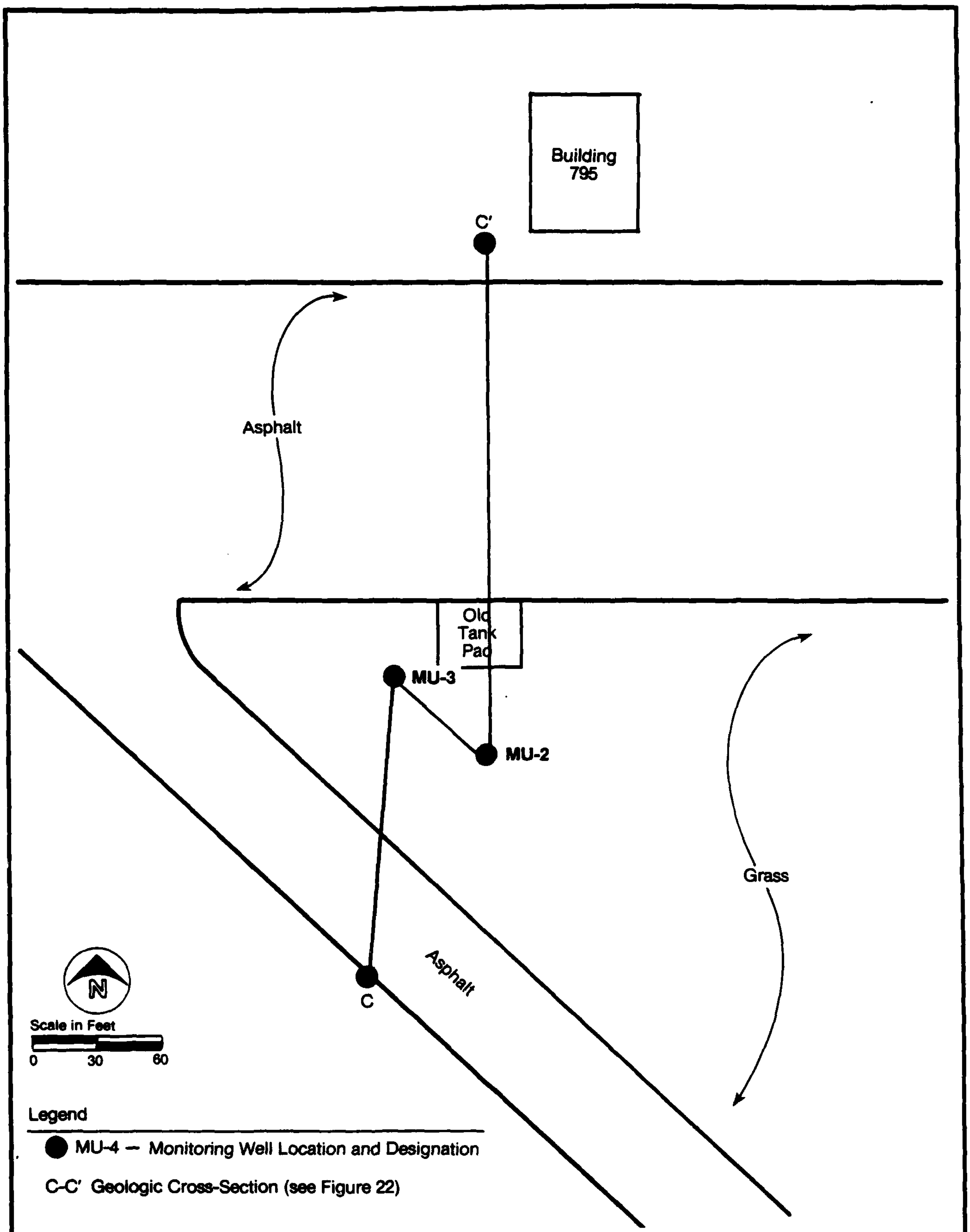


**FIGURE 18.**
Approximate Monitor Well Locations, Site 2, Underground Waste Fuel Storage Area, Moody AFB, Georgia.

upon reaching approximately 40 feet bls during the Well L-13D boring at Site 1, strong irritating vapors and organic vapor measurements, especially from the drill rods, forced an upgrade to Level C. Because organic vapors were highest when the drill rods and split-spoon were pulled out, split-spoon sampling was discontinued for health and safety reasons until the probable borehole completion depth was reached.

The drillers reported similar vapor problems near the bottom of the Well L-11S borehole at Site 1. However, instrumentation and observations of the field hydrogeologists did not confirm the presence of conditions requiring a Level C upgrade.

Although instrumentation was calibrated and maintained in accordance with TOP Sections 4.0 and 5.0, the HNu® photoionization detectors were inoperative for some periods of time. These malfunctions were possibly related to inclement weather.

The tightness of the subsurface formations and the initial depth to groundwater encountered, especially in the deep wells, made well development at both sites generally difficult. As a result, wells were developed to the extent practicable using a pitcher pump or a Teflon® bailer. The method of development and weather conditions were not conducive to obtaining systematic flow and water quality characterization outlined in Section 6.2.1 of the TOP. As indicated in the TOP, such characterization was based on the assumption that wells could be pumped at a relatively constant flow. Water yielded from the wells at the end of development was relatively clear, although some low-level turbidity remained in water yielded from the deep wells.

### 3.2.2 WATER QUALITY SAMPLING

This field program task was conducted during December 1-5, 1986. Two CH2M HILL experienced field engineering technicians were assigned as the sampling crew. Again, efforts were hampered by inclement weather. The field technicians used methods discussed in TOP Sections 10.1, 10.3, and 10.4 to perform water level measurements, onsite indicator analyses, and water and sediment sampling for offsite analyses. Field data collected during the water quality sampling effort are presented in Appendix D. A pitcher pump was used for pre-sample purging of monitor wells. Clean glass containers were used for collecting water and sediment samples from Site 3 locations, and transferring to appropriate containers. Decontamination procedures used to collect representative water and sediment samples are identified in TOP Sections 11.3, 11.4, and 11.5. Duplicate samples were delivered in the afternoon to the base bio-environmental staff who selected samples for

USAFOEHL analyses and packed the samples with materials provided by CH2M HILL. The field technicians shipped the packaged samples via Federal Express within 24 hours of sample collection. Sample custody and documentation procedures used by CH2M HILL on the project are outlined in TOP Section 13.0.

CH2M HILL surveyors were also onsite during December 1-3, 1986, to obtain the information outlined in TOP Section 10.2. Rebars were installed to mark locations of sampling locations at Site 3. A copy of the complete site survey is provided in Appendix K.

The location, type, number, and parameter coverage of all samples were specified in the SOW. Site 1 involved sampling the nine newly constructed Monitor Wells L-7S to L-15D, plus existing Monitor Wells L-1 and L-2 and Water Supply Well No. 7 east of Mission Lake (refer to Figure 16 for locations). Existing Well L-3 scheduled for sampling was never located during site reconnaissance or field program execution. Samples from Site 1 locations were analyzed for halogenated and aromatic volatile organics; extractable priority pollutants; priority pollutant metals; selenium, arsenic, and mercury; and TDS. Site 2 involved sampling the four newly constructed Monitor Wells MU-1 to MU-4 (refer to Figure 18 for locations). Samples from Site 2 locations were analyzed for aromatic volatile organics and petroleum hydrocarbons. Site 3 involved obtaining water and sediment samples at five locations indicated in Figure 18. Sample locations S-4 and S-5 were established with the concurrence of the program manager and base personnel after the November 12, 1986, reconnaissance revealed that locations proposed in the TOP were not in channels containing water. Samples from Site 3 locations were analyzed for halogenated and volatile organics, petroleum hydrocarbons, and lead. Site 4 samples were collected from the existing Water Supply Well No. 10 at the Grassy Pond Annex, for halogenated and volatile organics analyses.

Before starting this field program task, sample container labels and chain of custody forms were completed in the office to the extent possible. This greatly minimized confusion in the field and promoted quicker execution of the task, especially considering weather conditions that prevailed during most of the task.

The sampling survey started on the afternoon of Monday, December 1, 1986, at Site 3 and included sampling of Water Supply Well No. 7 east of Mission Lake. The locations of the Site 3 water quality and sediment sampling points are shown in Figure 19. Work at this site was completed the next morning and the survey proceeded to Site 2. Pre-sample purging of the monitor wells evacuated the wells entirely and recovery of water levels was generally found to be slow.

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**LEGEND**

S-1 ■ Surface Water Sediment Sampling Points and Designation

Scale in Feet

0 200

**FIGURE 19.**
Approximate Surface Water/Sediment Sampling Locations, Site 3, Flightline Storm Drain Outfall, Moody AFB, Georgia.

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As a result, the field team decided (pursuant to the TOP) to purge the wells dry Tuesday morning and allow overnight recharge to the extent possible before obtaining samples. Following the Site 2 well evacuations, the survey proceeded Tuesday afternoon to Site 1 where similar conditions were encountered. As a result, four Site 1 monitor wells were also purged. The following day, the previously purged wells at both sites were sampled and two additional Site 1 wells were evacuated. Purging and sampling at Site 1 was completed late Thursday afternoon, with the exception of Well L-13D, and Water Supply Well No. 10 at Site 4 (Grassy Pond Annex) was also sampled on that day.

Sampling of Well L-13D at Site 1 was attempted on Thursday, December 4, 1986, but was prevented by a blockage in the well located approximately 18 feet below the top of casing. Bailer contents brought up some PVC shavings and sand, indicating that the casing may have cracked and sanded in. However, additional efforts the following morning revealed the casing was not cracked but a cloth rag used by the subcontractor had inadvertently been caught up during well construction. After removing the cloth rag with a hand pump, the well was purged and sampled.

In addition to the problems related to sampling Well L-13D, other problems were encountered during the sampling task. For example, the generally slow water level response in the monitor wells indicated that complete water level stabilization following sampling would take a considerable time. As a result, the field team decided to delay post-sample water level measurements (required by the SOW) until the testing phase of the field program.

Heavy rains persisted during the Site 3 sampling, resulting in conditions not generally conducive to characterizing surface waters as required in the SOW. Although calibrated and maintained in accordance with TOP Sections 4.0 and 5.0, instrumentation was inoperative for some periods of time. For example, the pH meter kept drifting from the baseline, which appeared to be a weather-related response.

### 3.2.3 TESTING

This field program task consisted of two phases: insitu testing of selected monitor wells and laboratory water quality analyses of collected samples.

#### 3.2.3.1 In-Situ Well Tests

This effort involved the use of slug tests to assess hydraulic characteristics of subsurface materials in contact with the screened interval in the immediate subsurface zone of each tested well. The tests were conducted during

January 12-16, 1987, and involved the procedures outlined in TOP Section 6.2.2. An Enviro-Labs® pressure transducer data recording system was used to record water level responses induced by field procedures.

Efforts from the sampling task of the field program indicated that conditions were not conducive to performing specific capacity and recovery tests on the monitor wells, as addressed in the SOW. Wells could not be pumped at a constant flow rate and water level responses appeared limited in many wells which could have substantially extended testing periods. These considerations were discussed with the program manager on December 10, 1986. As a result, only slug tests were performed on Wells L-8S, L-10S, L-11S, L-14D, and L-15D at Site 1, and on Wells MU-1, MU-3, and MU-4 at Site 2. However, tests were also run on Well L-13D for additional information.

3.2.3.2 Laboratory Testing

This effort involved performing actual chemical analyses required by the SOW. All analyses were performed in accordance with standard methods specified in the SOW. The CH2M HILL laboratory in Gainesville, Florida, was responsible for overall sample handling, custody, and documentation in addition to performing analyses on all samples for halogenated and aromatic hydrocarbons, and TDS. Analyses for extractable priority pollutants and priority pollutant metals were conducted in CH2M HILL's laboratory in Montgomery, Alabama. Analyses for selenium, arsenic, mercury, and lead were conducted in the CH2M HILL laboratory in Corvallis, Oregon. Analyses for petroleum hydrocarbons were subcontracted to Technical Services, Inc., in Jacksonville, Florida.

A summary of sampling methods, detection levels, and holding times involved with these analyses is presented in Appendix L. Chain of custody forms, laboratory analytical report forms, and laboratory quality assurance/quality control (QA/QC) data are presented in Appendix F.

## Section 4
## RESULTS AND CONCLUSIONS

### 4.1 DISCUSSION OF RESULTS

#### 4.1.1 HYDROGEOLOGIC INVESTIGATIONS

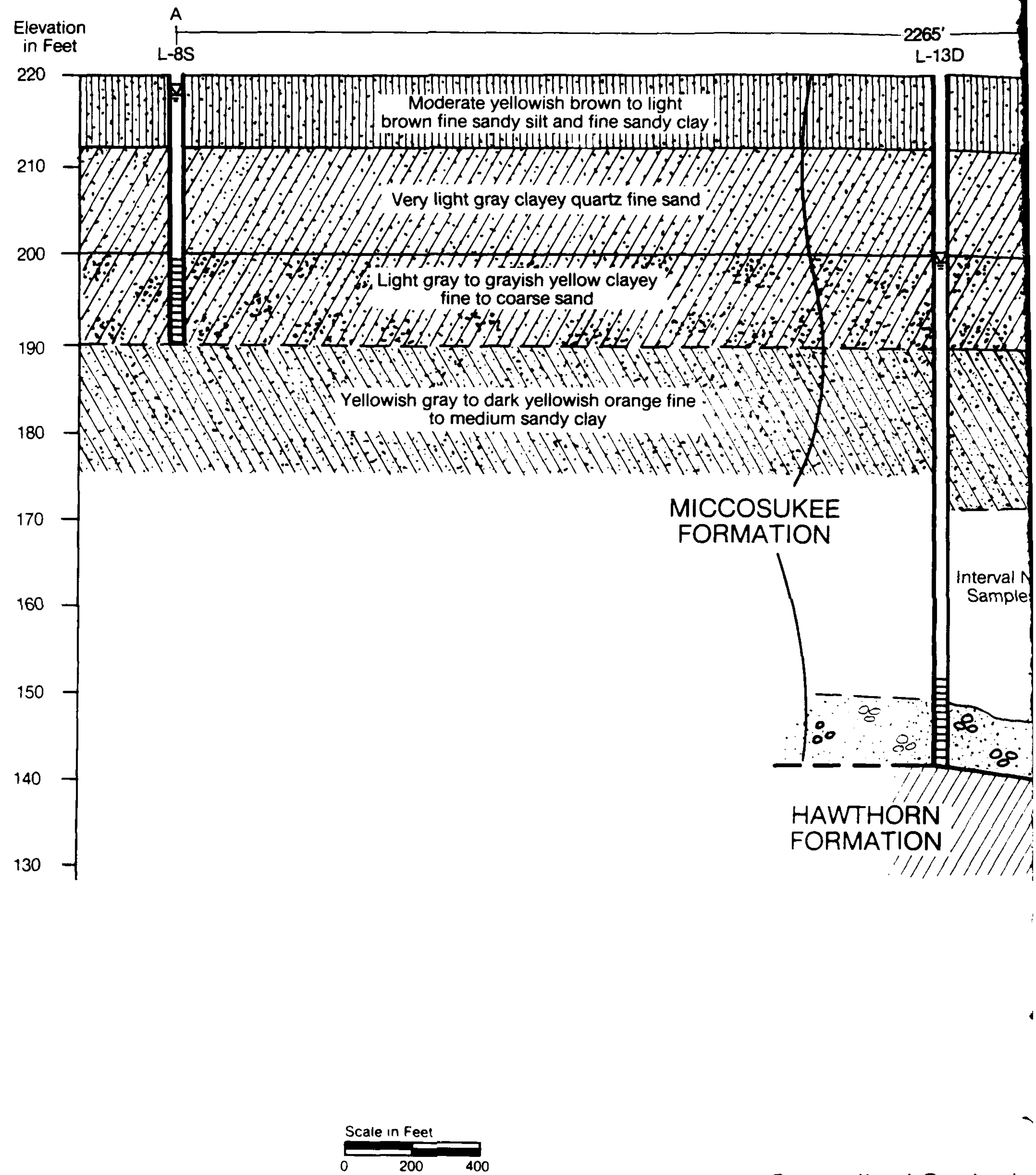
Sections 3.2.1 and 3.2.3 outlined the hydrogeologic field program tasks of the project and procedures used in reference to applicable portions of the TOP. This section presents the results from these tasks.

Generalized geologic cross-sections for Site 1 based on boring logs for monitor wells installed during the field program are shown in Figures 20 and 21. The locations of the Site 1 cross-sections are shown in Figure 16. A generalized geologic cross-section for Site 2 based on monitor wells installed at that site is presented in Figure 22; the location of the Site 2 cross-section is shown in Figure 18. The cross-sections are the basis for the description of shallow geologic and hydrogeologic conditions previously provided in Section 2. Subsurface conditions for at least the first 30 feet appear to be relatively consistent throughout the Site 1 and Site 2 areas. Deeper borings were performed only in the Site 1 area.

Shallow groundwater was expected to be encountered at depths of 10 to 20 feet bls in the Site 1 and 2 areas. However, no phreatic surface was initially observed during site borings until a depth of 25 to 30 feet bls was reached. At this point, moisture content increased and water levels were found to eventually rise to anticipated levels.

The estimated shallow groundwater elevations at Site 1 during April 1984, September 1984, and January 1987, are shown in Figures 23, 24, and 25, respectively. Available groundwater measurements are summarized in Table 8. WAR conducted the 1984 measurements during the previous Phase II Stage 1 investigation. CH2M Hill also measured the water levels in December 1986 before obtaining water quality samples; however, data from some wells known to be upgradient reflected water levels that were depressed or recovering and were not considered representative. Water level contours were estimated by linear interpolation between available data points and should be considered accurate only to the degree implied by the method used.

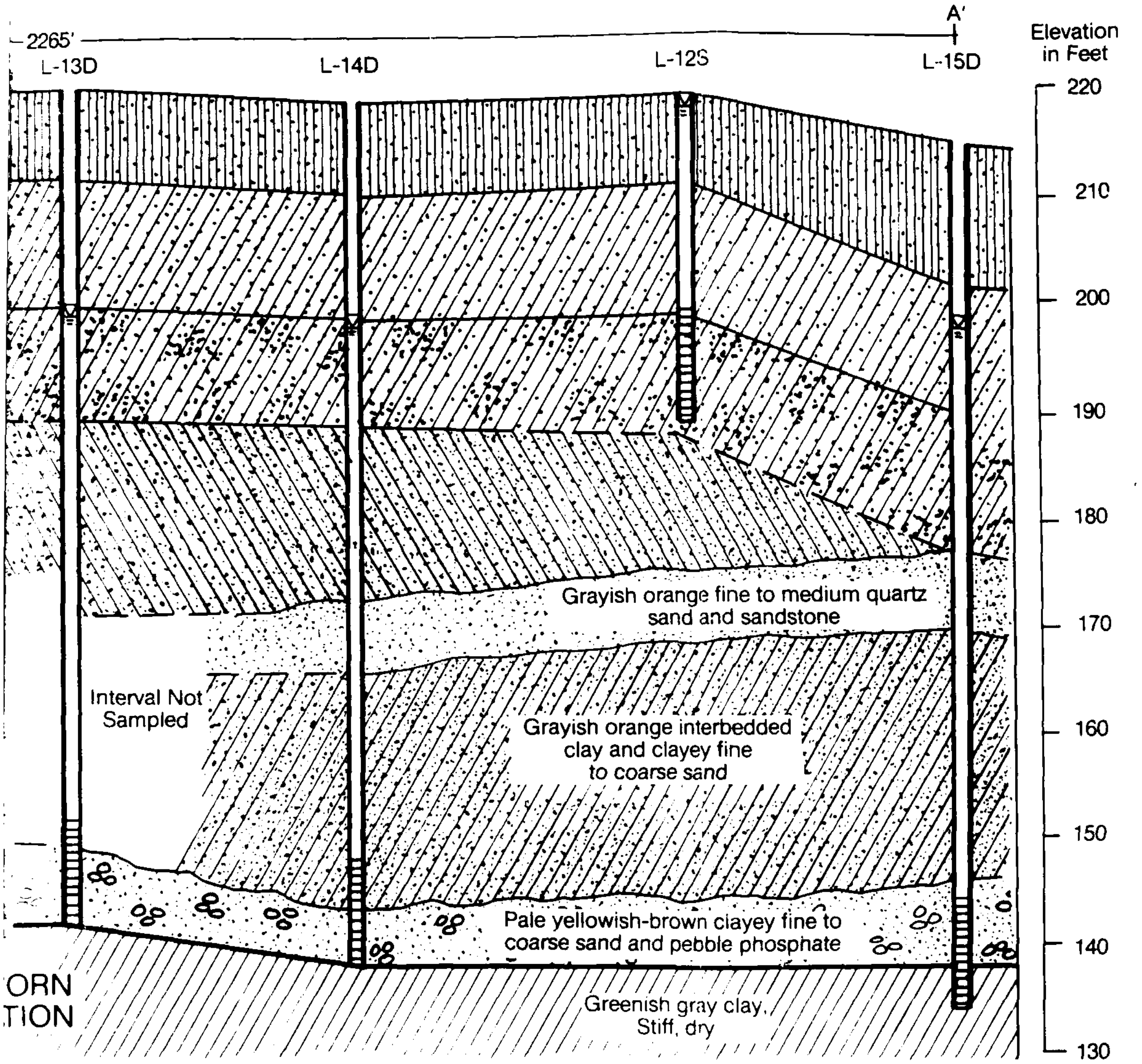
The water level maps indicate that shallow groundwater at Site 1 generally moves in a northeasterly direction towards the Mission Lake drainage system. Based on available data, it appears that shallow groundwater in the western base area




Generalized Geologic

...imate Monitor Well Locations, Site 1, Southwest Landfill, Moody AFB, Georgia.






See Figure 16 for cross-section location.
Water table elevations shown are from measurements taken in January 1987.

**FIGURE 20.**
...ed Geologic Cross-Section A-A', Site 1, Southwest Landfill, Moody AFB, Georgia.

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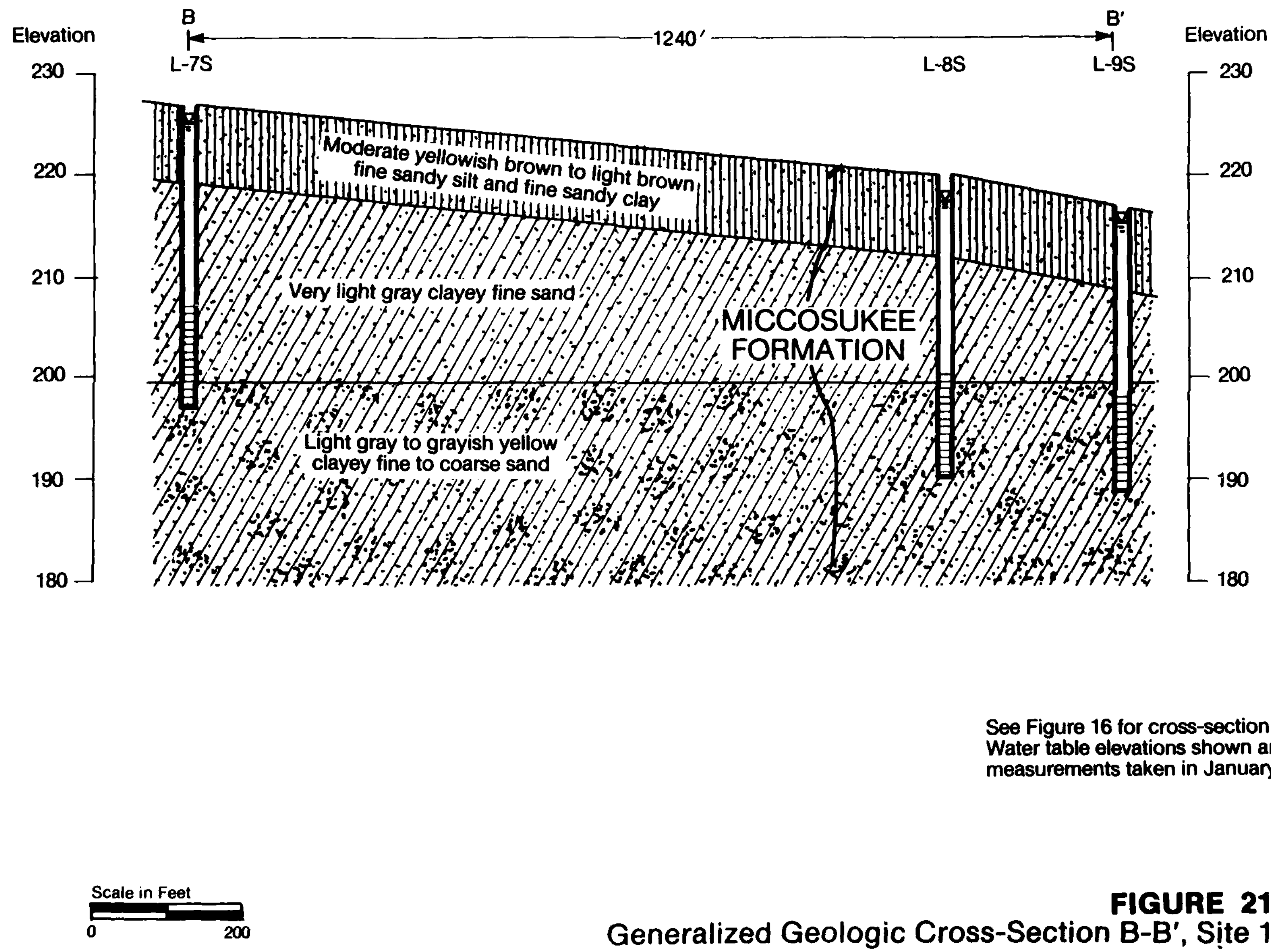


See Figure 16 for cross-section location. Water table elevations shown are from measurements taken in January 1987.

**FIGURE 21.**
Generalized Geologic Cross-Section B-B′, Site 1, Southwest Landfill, Moody AFB, Georgia.

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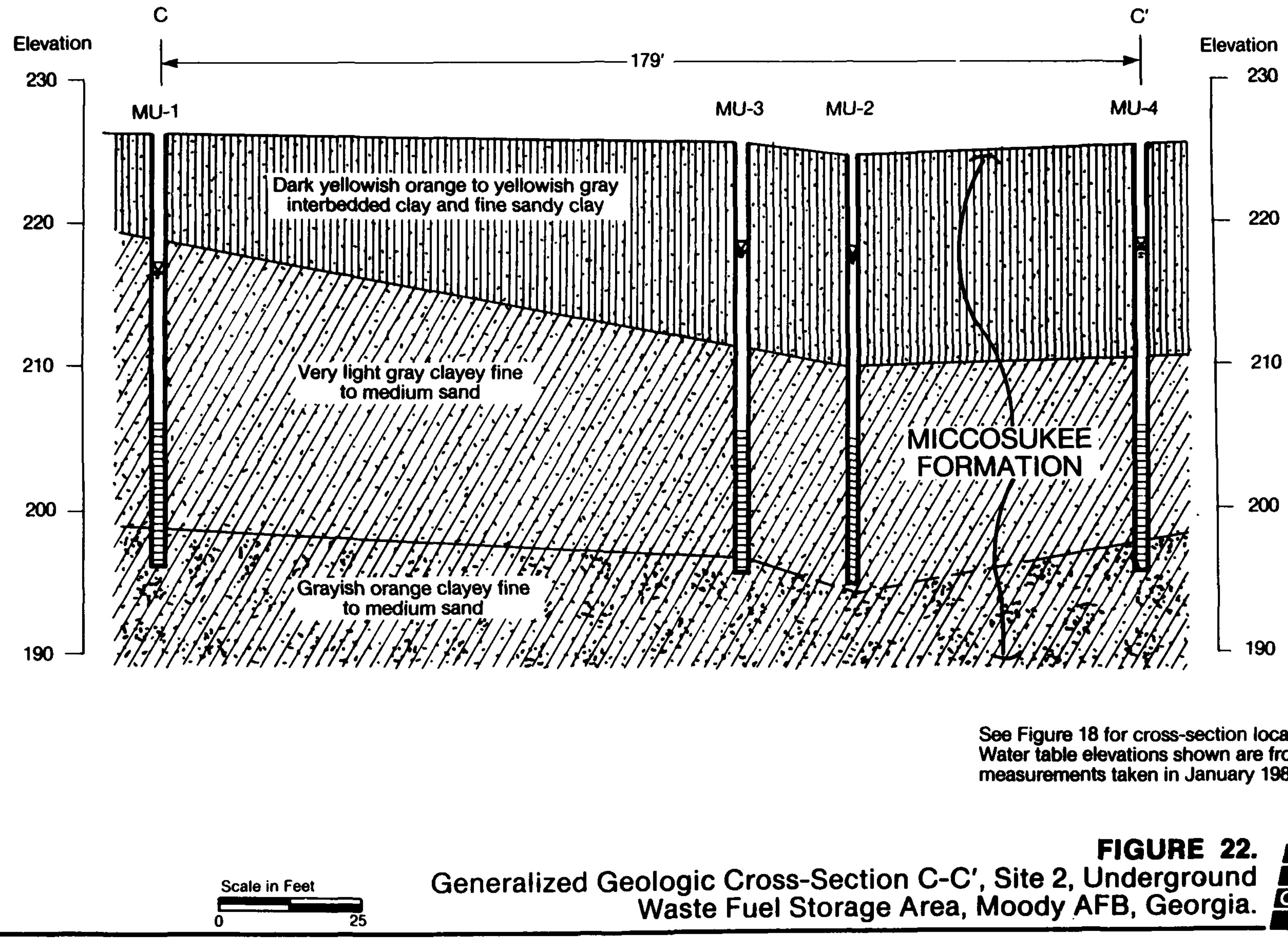


See Figure 18 for cross-section location. Water table elevations shown are from measurements taken in January 1987.

**FIGURE 22.**
Generalized Geologic Cross-Section C-C′, Site 2, Underground Waste Fuel Storage Area, Moody AFB, Georgia.

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**FIGURE 23.**
Approximate Shallow Groundwater Elevations,
Site 1, Southwest Landfill, April 1984, Moody AFB, Georgia.


**FIGURE 24.**
Approximate Shallow Groundwater Elevations, Site 1, Southwest Landfill, September 1984, Moody AFB, Georgia.

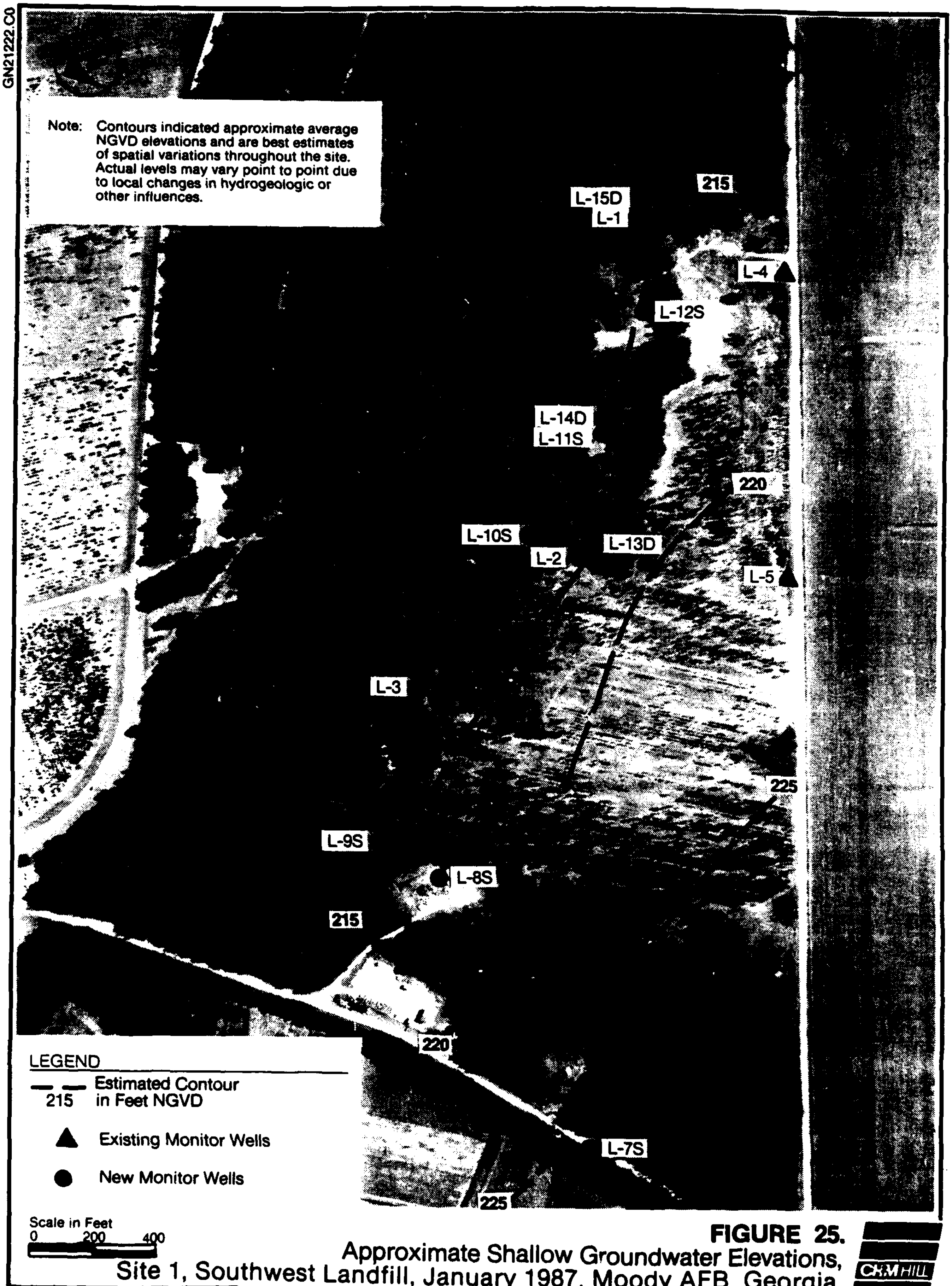


**FIGURE 25.**
Approximate Shallow Groundwater Elevations,
Site 1, Southwest Landfill, January 1987, Moody AFB, Georgia.

Table 8
SUMMARY OF SHALLOW GROUNDWATER MEASUREMENTS AT SITE 1, SOUTHWEST LANDFILL
MOODY AFB, GEORGIA

| | | Phase II, Stage I Study[a] | | | | Phase II, Stage 2 Study[b] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | April 1984 | | September 1984 | | December 1986[c] | | January 1987[d] | |
| Well Designation | Top of Casing (NGVD)[e] | Depth to Water (ft) | Water Elevation (ft-NGVD) | Depth to Water (ft) | Water Elevation (ft-NGVD) | Depth to Water (ft) | Water Elevation (ft-NGVD) | Depth to Water (ft) | Water Elevation (ft-NGVD) |
| L-1 | 218.39 | 5.00 | 213.4 | 9.48 | 208.9 | 11.28 | 207.11 | 3.31 | 215.08 |
| L-2 | 222.85 | 7.12 | 215.7 | 11.33 | 211.5 | 11.89 | 206.71 | 3.79 | 214.81 |
| L-3 | 218.60 | 5.04 | 213.6 | 7.17 | 211.4 | -- | -- | -- | -- |
| L-4 | 222.29 | 5.75 | 216.4 | 10.33 | 212.0 | -- | -- | -- | -- |
| L-5 | 227.53 | 9.17 | 218.4 | 14.38 | 213 2 | -- | -- | -- | -- |
| L-6 | 237.47 | 5.81 | 231.7 | 14.02 | 223.4 | -- | -- | -- | -- |
| L-7S | 230.06 | -- | -- | -- | -- | 12.40 | 217.66 | 4.49 | 225.57 |
| L-8S | 222.77 | -- | -- | -- | -- | 9.43 | 213.34 | 5.12 | 217.65 |
| L-9S | 219.66 | -- | -- | -- | -- | 7.12 | 212.54 | 3.90 | 215.76 |
| L-10S | 220.40 | -- | -- | -- | -- | 9.63 | 210.77 | 5.68 | 214.72 |
| L-11S | 222.31 | -- | -- | -- | -- | 11.86 | 210.45 | 6.40 | 215.91 |
| L-12S | 222.63 | -- | -- | -- | -- | 12.26 | 210.37 | 5.72 | 216.91 |
| L-13D | 223.85 | -- | -- | -- | -- | --[f] | --[f] | 24.60 | 199.25 |
| L-14D | 222.31 | -- | -- | -- | -- | 27.57 | 194.74 | 23.82 | 198.49 |
| L-15D | 219.14 | -- | -- | -- | -- | 25.72 | 193.42 | 22.02 | 197.12 |

[a]Measurements made by WAR, Inc.

[b]Measurements made by CH2M HILL, Inc.

[c]Measurements before obtaining water quality samples.

[d]Measurements before performing slug testing.

[e]Elevations for L-1 to L-6 established by WAR, Inc. Elevations for L-7S to L-15D established by CH2M HILL on north side of casing.

[f]Water level not taken because of well blockage (subsequently removed).

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feeds this drainage system at least seasonally. The hydraulic gradient of the shallow groundwater in the Site 1 area appears to range from .005 to .01 foot/foot (ft./ft.). WAR previously estimated the gradient at the site to be .005 ft./ft. An average gradient of .005 ft./ft. appears representative for Site 1 based on available water level measurements and a probable regional shallow groundwater gradient towards Mission Lake.

Estimated shallow groundwater elevations at Site 2 during December 1986 and January 1987 are shown in Figures 26 and 27, respectively. Shallow groundwater measurements are shown in Table 9. Water level contours were estimated by linear interpolation from the four available data points at this site and should be considered accurate only to the degree implied by the method used. The figures indicate that shallow groundwater at Site 2 generally moves in a southwesterly direction towards the Mission Lake drainage system. Based on available data, it appears that shallow groundwater in the western base area feeds this drainage system at least seasonally. From the two sets of data, the gradient of the shallow groundwater in the Site 2 area appears to range from .003 to .005 ft./ft. An average gradient of .004 appears representative for Site 2 based on available water level measurements and a probable regional shallow groundwater flow gradient towards Mission Lake.

At Site 1, three pairs of monitor wells are located adjacent to each other: Wells L-1 and L-15D, L-11S and L-14D, and L-2 and L-13D (Figure 16). The shallow wells are about 30 feet deep and the deep wells are approximately 80 feet deep. The wells are screened over the bottom 10 feet of depth. January 1987 water level measurements (refer to Table 8) indicate an average water level difference of approximately 17 feet between the shallow and deep wells. The Miccosukee Formation appears to comprise several "semi-confined" zones, and the Hawthorn Formation serves as a regional confining unit for underlying limestone. The measured difference in head indicates a strong downward vertical hydraulic gradient within the surficial aquifer system. Although data are limited, comparison of water levels in the deeper wells also indicates that flow near the base of the water table aquifer may be more easterly at a lesser gradient than for the shallower water table flow.

As previously discussed in Section 3.2.3.1, slug tests were performed in selected monitor wells at Sites 1 and 2. These tests involve procedures to obtain indicator estimates of the lateral hydraulic conductivity in the immediate vicinity of the subsurface zone penetrated by the well screens. Test procedures used are described in TOP Section 6.2.2. Reduced water level response data from the slug tests are included in Appendix D.

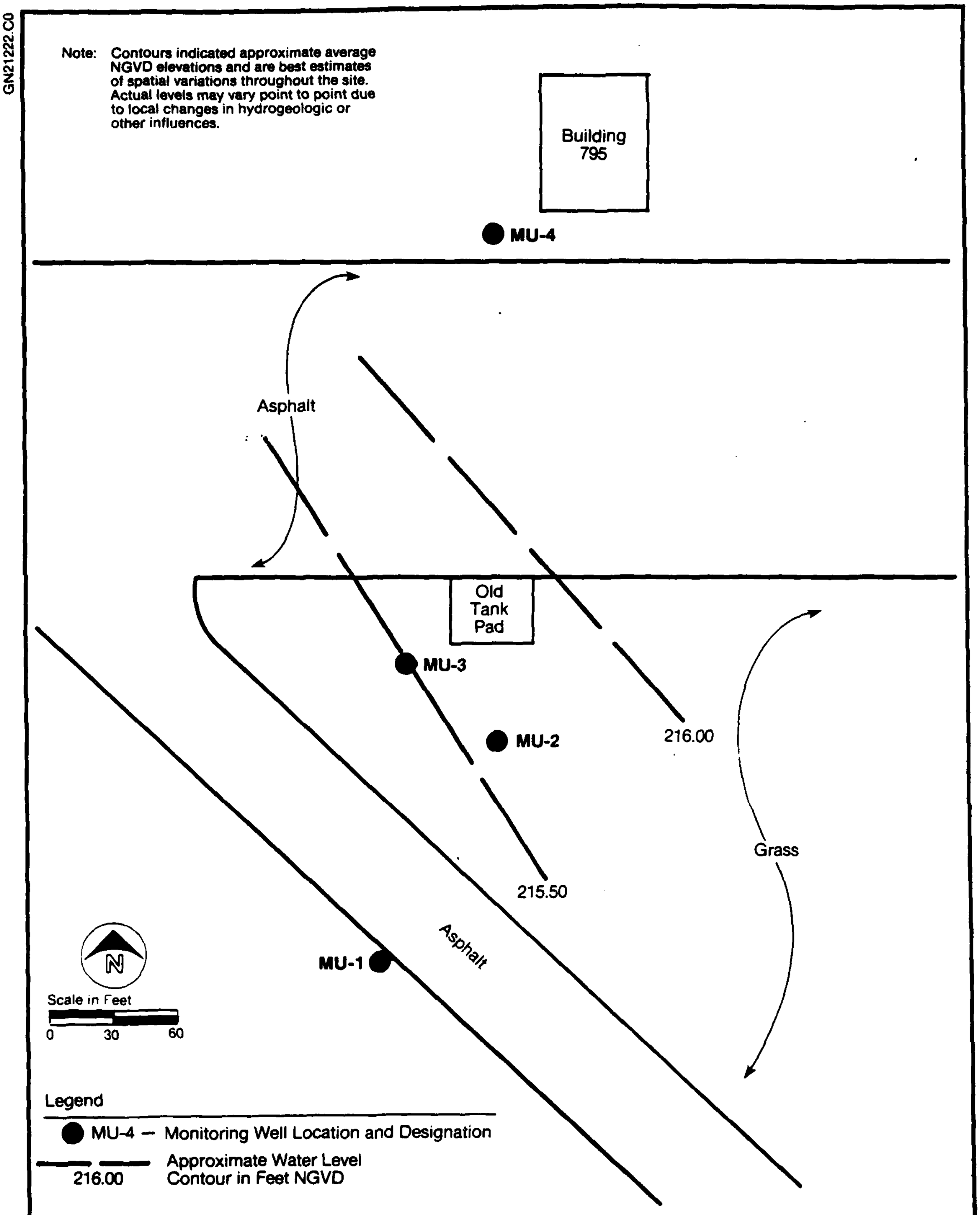


**FIGURE 26.**
Approximate Groundwater Elevation, Site 2, Underground Waste Fuel Storage Area, December 1986, Moody AFB, Georgia.

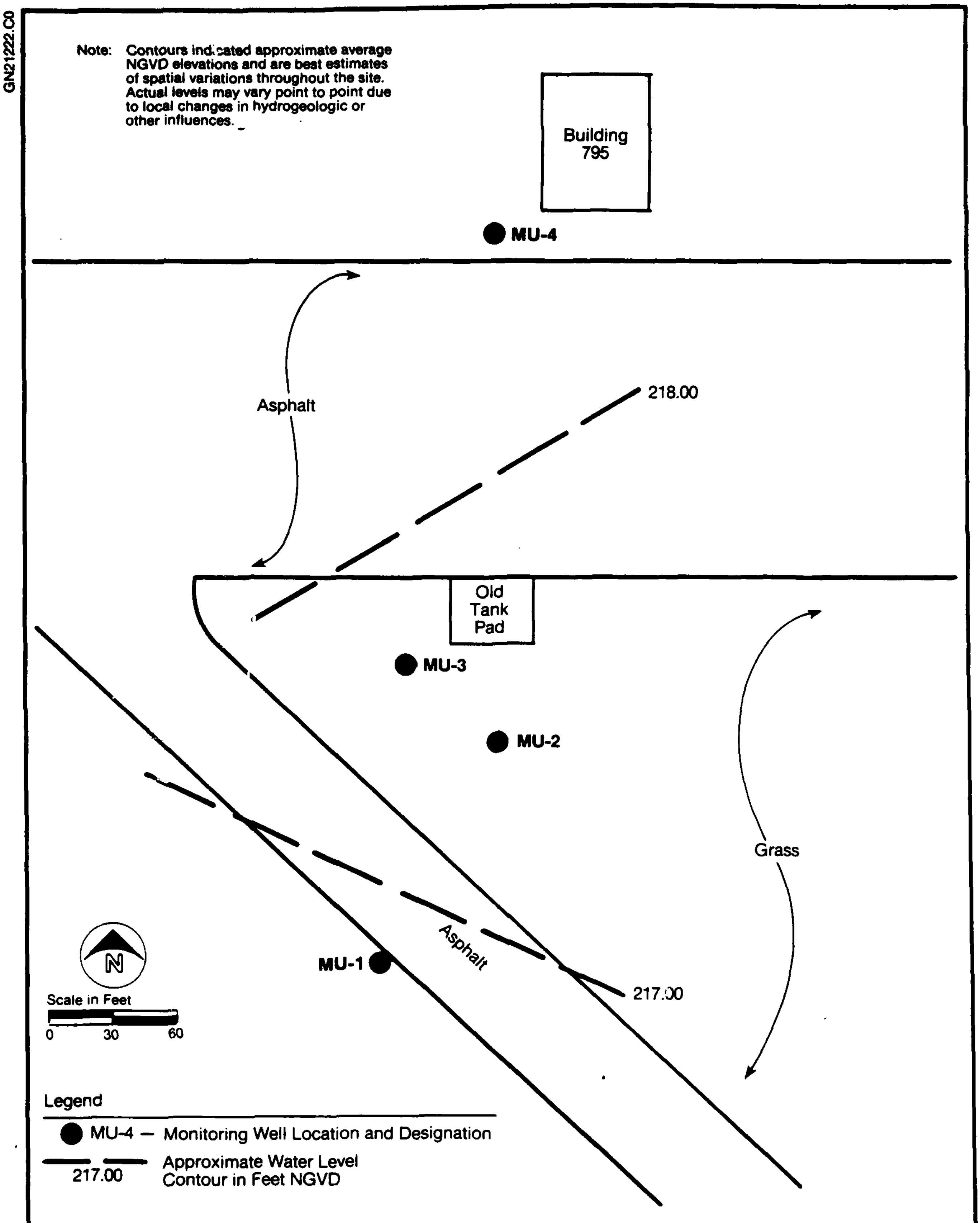


**FIGURE 27.**
Approximate Groundwater Elevations, Site 2, Underground Waste Fuel Storage Area, January 1987, Moody AFB, Georgia.

Table 9
SUMMARY OF SHALLOW GROUNDWATER MEASUREMENTS AT SITE 2, UNDERGROUND WASTE FUEL STORAGE AREA
MOODY AFB, GEORGIA

| Well Designation | Top of Casing (NGVD)[a] | December[b] Depth to Water (ft) | December[b] Water Elevation (ft-NGVD) | January[c] Depth to Water (ft) | January[c] Water Elevation (ft-NGVD) |
|---|---|---|---|---|---|
| MU-1 | 225.44 | 10.06 | 215.38 | 8.66 | 216.78 |
| MU-2 | 224.90 | 9.13 | 215.77 | 7.33 | 217.57 |
| MU-3 | 225.68 | 10.25 | 215.43 | 7.73 | 217.95 |
| MU-4 | 226.04 | 9.54 | 216.50 | 7.68 | 218.36 |

[a] Elevation established by CH2M HILL on north side of casing.

[b] Measured by CH2M HILL from north side of casing, before obtaining water quality samples.

[c] Measured by CH2M HILL from north side of casing.

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Several methods of analyzing slug test data exist. TOP Section 6.2.2 provided references for the particular methods to be utilized in evaluating the data obtained from Sites 1 and 2. All the identified methods were examined, but only three produced consistent results: Hvorslev, Bouwer and Rice, and the U.S. Navy. These methods involve similar analytical expressions, relating water level responses, well construction and aquifer geometry to solve for hydraulic conductivity using the straight line portions of plotted water level response data. The methods are theoretically for unconfined aquifers but are probably valid for "semi-confined" conditions like those apparently encountered at Sites 1 and 2. The other two methods, Cooper et al. (1967) and Nguyen and Pinder (1984), are more graphical solutions for use on confined aquifers; this is probably the reason that the methods were not applicable to the slug test data obtained.

The results of the slug test analyses and a summary of the probable representative lateral hydraulic conductivities for the corresponding subsurface intervals tested are shown in Table 10. The probable range and average values for the 20- to 30-foot depth are consistent with typical "textbook" permeability rates for mixtures of fine sands, silts, and clays. The probable range and average values for the 70- to 80-foot depth are consistent with typical "textbook" permeability rates for coarse to fine sands with gravelly material.

Previous tests conducted by WAR on Well L-4 (refer to Figure 16) indicated an average lateral hydraulic conductivity for the upper Miccosukee Formation on the order of 0.03 feet per day (ft/d), which is about one order of magnitude less permeable than reported in Table 10. However, Well L-4 was screened from 5 to 25 feet bls. This probably accounts for the reduced permeability by reflecting the lower permeability of the upper 8- to 10-foot zone of silty and clayey materials that appears to underlie the area, and the limited penetration of Well L-4 into the more permeable zone where the new shallow wells were completed.

The available data do not reflect an average lateral hydraulic conductivity for the entire Miccosukee Formation. However, considering similarities within the generalized geologic profile shown in Figure 20, available hydraulic conductivity data for some zones within the profile, and assumed "typical" permeability values for these zones in the profile not measured, it appears that the average value of 0.60 ft/d (provided in Table 10) for the 20 to 30 foot depth may be a reasonable average estimate for the Miccosukee Formation as a unit. This estimated value would apply only to the general area of Sites 1 and 2 and assumes that the profile remains essentially uniform spatially throughout the area.

Table 10
RESULTS OF SLUG TEST ANALYSES[a]
MOODY AFB, GEORGIA

| Test Well Designation | Location | Approximate Well Depth[b] (feet) | Average Lateral Hydraulic Conductivity in Feet Per Day[c]: Hvorslev | Bouwer and Rice | U.S. Navy | Average |
|---|---|---|---|---|---|---|
| L-8S | Site 1 | 30 | 1.25 | 0.43 | 0.71 | 0.80 |
| L-10S | Site 1 | 30 | 0.66 | 0.24 | 0.39 | 0.65 |
| L-11S | Site 1 | 30 | 0.46 | 0.28 | 0.48 | 0.61 |
| L-13D | Site 1 | 80 | 4.00 | 3.13 | 3.98 | 3.70 |
| L-14D | Site 1 | 80 | 2.90 | 1.71 | 2.14 | 2.25 |
| L-15D | Site 1 | 80 | 0.17[d] | 0.15[d] | 0.18[d] | 0.17[d] |
| MU-1 | Site 2 | 30 | 0.27 | 0.15 | 0.26 | 0.23 |
| MU-3 | Site 2 | 30 | 1.31 | 0.58 | 0.98 | 0.96 |
| MU-4 | Site 2 | 30 | 0.61 | 0.32 | 0.54 | 0.49 |

SUMMARY OF TESTS

| Representative Subsurface Depth in Feet bls | Probable Representative Lateral Hydraulic Conductivity in Feet Per Day: Range | Average |
|---|---|---|
| 20-30 | 0.15-1.30 | 0.60 |
| 70-80 | 1.70-4.00 | 3.0 |

[a]Testing and analyses performed by CH2M HILL. Refer to Section 6.2.2 of TOP for test procedures.

[b]Wells are screened over the bottom ten feet of depth.

[c]Section 6.2.2 of TOP contains references for the analytical methods indicated.

[d]Probably not representative from possible plugging of screened interval and well penetration into the Hawthorn Formation. Not included in data summary information.

### 4.1.2 WATER QUALITY INVESTIGATIONS

Section 3.2.2 outlined the water quality sampling tasks of the project and procedures used by reference to the applicable portions of the TOP. This section presents the results from this task for each site. Summaries of field data obtained during the sampling work are presented in Appendix D. Laboratory analytical reports, and QA/QC data are contained in Appendix F. Information pertaining to the nature, source, fate, transport, and public health effects of measured parameters is presented in Section 4.2.

#### 4.1.2.1 Site 1. SOUTHWEST LANDFILL

New monitor wells (L-7S to L-15D), two existing monitor wells (L-1, L-2), and one water supply well (WSW 7) were sampled and analyzed for halogenated and aromatic VOC's; petroleum hydrocarbons; base/neutral and acid extractable compounds; priority pollutant metals scan; arsenic, mercury, and selenium; and TDS. Summaries of recent and past sampling by WAR (as applicable) for the Site 1 sampling locations (including Water Supply Well No. 7) are presented in the three parts of Table 11. Several pesticides and herbicides were analyzed for, but none were detected in samples collected from Site 1 by WAR. CH2M HILL did not analyze for any pesticides or herbicides.

No individual well was sampled for VOC's during both the WAR and CH2M HILL field programs so comparisons over time are not possible. However, Wells L-6 and L-7S are both "background" wells located hydraulically upgradient from the site which showed no significant levels of VOC's during 1984 and 1986 sampling (by WAR and CH2M HILL, respectively).

Information pertaining to VOC analyses is presented in Part I of Table 11. VOC concentrations measured in monitor wells at Site 1 were generally low (e.g., less than 10 µg/l), with the exception of a dichloromethane concentration of 3,600 µg/l measured in L-13D, a deep well. Dichloromethane and xylene were the most frequently detected VOC's, with levels above the detection limit of 1 µg/l in seven of the twelve monitor wells sampled. During investigations in 1984, WAR did not detect either of these contaminants in the two wells they sampled at Site 1. A xylene concentration of 400 µg/l was detected by CH2M HILL in L-15D. Of all the monitor wells at Site 1, Wells L-13D and L-15D had the highest levels of total VOC's measured; however, only one or two VOC's were detected in each well. Wells L-2 and L-10S, located close together, had the next highest total VOC concentrations, and numerous VOC's were detected in these two wells. L-2 had a total VOC concentration of 136 µg/l consisting primarily of chloroethane, dichloromethane, toluene, and xylene. 1,1-Dichloroethane,

Table 11

PART I--SUMMARY OF WATER QUALITY DATA[a], SITE 1, SOUTHWEST LANDFILL

MOODY AFB, GEORGIA

| Sample Designation | Date | Sampled By | Sample Number | Type of Sample | Volatile Organics (µg/l)[b] Benzene | Chloro-Benzene | Chloro-Ethane | Chloro-Form | 1,4-Di-Chloro-Benzene | 1,1-Di-Chloro-Ethane | 1,2-Di-Chloro-Ethane | 1,1-Di-Chloro-Ethene | Di-Chloro-Methane | Ethyl Benzene | Toluene | Tri-Chloro-Ethene | Vinyl Chloride | Xylene |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ML-1 | 03-Dec-86 | CH2M HILL | 37804 | Groundwater | BMDL[c] | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |
| ML-2 | 04-Dec-86 | CH2M HILL | 37824 | Groundwater | 1.5 | BMDL | 12 | BMDL | BMDL | 4.8 | 1.7 | BMDL | 34 | 3.4 | 61 | 1.5 | 5.0 | 11 |
| ML-3 | Sept-84 | WAR | -- | Groundwater | 3.7 | 9.2 | BMDL | BMDL | 8.8 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 2.1 | BMDL | BMDL |
| ML-6 | Sept-84 | WAR | -- | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |
| ML-7S | 03-Dec-86 | CH2M HILL | 37805 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 1.8 | ND[e] | ND | BMDL | BMDL | 3.1 |
| ML-8S | 03-Dec-86 | CH2M HILL | 37806 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 1.9 | ND | 2.3 | BMDL | BMDL | 3.7 |
| ML-9S | 03-Dec-86 | CH2M HILL | 37807 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | ND |
| ML-9D | 03-Dec-86 | CH2M HILL | 37808 | Duplicate (ML-9S) | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |
| ML-10S | 05-Dec-86 | CH2M HILL | 37825 | Groundwater | 2.1 | 1.8 | ND | 6.3 | 4.1 | 11 | 11 | 2.8 | 23 | 1.8 | 11 | 2.4 | 18 | 5.4 |
| ML-11S | 03-Dec-86 | CH2M HILL | 37809 | Groundwater | BMDL | BMDL | BMDL | 1.3 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |
| ML-12S | 04-Dec-86 | CH2M HILL | 37826 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 2.3 | BMDL | BMDL | BMDL | BMDL | BMDL |
| ML-13D | 05-Dec-86 | CH2M HILL | 37827 | Groundwater | <500 | <500 | <500 | <500 | <500 | <500 | <500 | <500 | 3600 | <500 | <500 | <500 | <500 | <500 |
| ML-14D | 04-Dec-86 | CH2M HILL | 37828 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 5.5 | BMDL | BMDL | BMDL | BMDL | BMDL |
| ML-15D | 03-Dec-86 | CH2M HILL | 37810 | Groundwater | <50 | <50 | <50 | 21[d] | <50 | <50 | <50 | <50 | ND | 130 | ND | <50 | <50 | 400 |
| MLSW-7 | 01-Dec-86 | CH2M HILL | 37752 | Supply Well #7 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |
| -- | 03-Dec-86 | CH2M HILL | 37811 | Travel Blank | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 1.4 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |
| -- | 04-Dec-86 | CH2M HILL | 37829 | Bailer Blank | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |
| -- | 04-Dec-86 | CH2M HILL | 37830 | Travel Blank | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL |

[a] Locations and sampling parameters in accordance with 9-30-86 SOW unless otherwise indicated elsewhere. Refer to Figure 16 for monitor well locations.

[b] Parameters measured pursuant to EPA Methods 601 and 602.

[c] Below method detection limit. Method detection limit is 1 µg/l unless otherwise indicated.

[d] Presence indicated, but less than method detection limit.

[e] Not determined. (Secondary column analysis does not confirm primary column results).

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Table 11
PART II--SUMMARY OF WATER QUALITY DATA[a], SITE 1, SOUTHWEST LANDFILL
MOODY AFB, GEORGIA

| Sample Designation | Date | Sampled By | Sample Number | Type of Sample | Base/Neutral and Acid Extractable Organics (μg/l)[b]: Bis(2-Ethyl-Hexyl) Phthalate | m,p-Cresol | Napthalene | Phenol | Diethyl Phthalate | N,N-Di-Methyl-Acetamide | Substituted Hexanoic Acids | Benzene Acetic Acid | Petroleum Hydrocarbons[c] (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ML-1 | 03-Dec-86 | CH2M HILL | 37804 | Groundwater | BMDL[d] | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 7.5 |
| ML-2 | 04-Dec-86 | CH2M HILL | 37824 | Groundwater | BMDL | 150 | 1.4[e] | 13 | 13 | BMDL | 43 | 10 | <0.4 |
| ML-3 | Sept-84 | WAR | -- | Groundwater | NA[f] | NA | NA | NA | NA | NA | NA | NA | NA |
| ML-6 | Sept-84 | WAR | -- | Groundwater | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ML-7S | 03-Dec-86 | CH2M HILL | 37805 | Groundwater | 370 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | <0.5 |
| ML-8S | 03-Dec-86 | CH2M HILL | 37806 | Groundwater | 210 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | <0.4 |
| ML-9S | 03-Dec-86 | CH2M HILL | 37807 | Groundwater | 220 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | <0.5 |
| ML-9D | 03-Dec-86 | CH2M HILL | 37808 | Duplicate (ML-9S) | 97 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | <0.3 |
| ML-10S | 05-Dec-86 | CH2M HILL | 37825 | Groundwater | 160 | 11 | 2.1[e] | 2.8[e] | 17 | BMDL | BMDL | BMDL | 10.9 |
| ML-11S | 03-Dec-86 | CH2M HILL | 37809 | Groundwater | 120 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 18.8 |
| ML-12S | 04-Dec-86 | CH2M HILL | 37826 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 11.1 |
| ML-13D | 05-Dec-86 | CH2M HILL | 37827 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 11.9 |
| ML-14D | 04-Dec-86 | CH2M HILL | 37828 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 10.5 |
| ML-15D | 03-Dec-86 | CH2M HILL | 37810 | Groundwater | BMDL | BMDL | BMDL | BMDL | BMDL | 26 | BMDL | BMDL | 11.7 |
| MLSW-7 | 01-Dec-86 | CH2M HILL | 37752 | Supply Well #7 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 31.2 |
| -- | 03-Dec-86 | CH2M HILL | 37811 | Travel Blank | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 11.6 |
| -- | 04-Dec-86 | CH2M HILL | 37829 | Bailer Blank | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | <0.4 |
| -- | 04-Dec-86 | CH2M HILL | 37830 | Travel Blank | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 9.0 |

[a] Locations and sampling parameters in accordance with 9-30-86 SOW unless otherwise indicated elsewhere. Refer to Figure 16 for monitor well locations.

[b] Parameters measured pursuant to EPA Method 625.

[c] Parameter measured pursuant to EPA Method 418.1.

[d] Below method detection limit. Method detection limit is 1 μg/l unless otherwise indicated.

[e] Presence indicated, but less than method detection limit.

[f] Not analyzed.

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Table 11
PART III--SUMMARY OF WATER QUALITY DATA[a], SITE 1, SOUTHWEST LANDFILL,
MOODY AFB, GEORGIA

| Sample Designation | Date | Sampled By | Sample Number | Priority Pollutant Metals Scan (mg/l)[b] Sb | Be | Cd | Cr | Cu | Ni | Pb | Ag | Tl | Zn | Metals (mg/l)[c] As | Hg | Se | TDS (mg/l)[d] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Drinking Water MCL | | | | -- | -- | 0.010 | 0.050 | 1.000[f] | -- | 0.050 | 0.050 | -- | 5.000[f] | 0.050 | 0.002 | 0.010 | 500[f] |
| ML-1 | 12-03-86 | CH2M HILL | 37804 | <0.050 | <0.0025 | 0.009 | 0.015 | 0.012 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.040 | <0.001 | 0.0006 | 0.009 | 70 |
| L-1 | 09-84 | WAR | -- | NA[e] | NA | <0.006 | <0.015 | NA | NA | <0.010 | <0.006 | NA | NA | <0.002 | 0.0001 | <0.004 | NA |
| L-2 | 09-84 | WAR | -- | NA | NA | <0.006 | <0.015 | NA | NA | <0.010 | <0.006 | NA | NA | <0.002 | 0.0002 | <0.004 | NA |
| ML-2 | 12-04-86 | CH2M HILL | 37824 | <0.050 | 0.007 | 0.009 | 0.170 | <0.005 | 0.040 | 0.080 | <0.0025 | <0.050 | 0.064 | <0.001 | 0.0007 | <0.005 | 100 |
| L-3 | 09-84 | WAR | -- | NA | NA | <0.006 | <0.015 | NA | NA | <0.010 | <0.006 | NA | NA | <0.002 | 0.0001 | <0.004 | NA |
| L-4 | 09-84 | WAR | -- | NA | NA | <0.006 | <0.015 | NA | NA | <0.010 | <0.006 | NA | NA | <0.002 | 0.0002 | <0.004 | NA |
| L-5 | 09-84 | WAR | -- | NA | NA | <0.006 | <0.015 | NA | NA | <0.010 | <0.006 | NA | NA | <0.002 | 0.0002 | <0.004 | NA |
| L-6 | 09-84 | WAR | -- | NA | NA | <0.006 | <0.015 | NA | NA | <0.010 | <0.006 | NA | NA | <0.002 | 0.0003 | <0.004 | NA |
| ML-7S | 12-03-86 | CH2M HILL | 37805 | <0.050 | <0.0025 | 0.010 | 0.012 | 0.008 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.026 | <0.001 | <0.0002 | 0.006 | 156 |
| ML-8S | 12-03-86 | CH2M HILL | 37806 | <0.050 | <0.0025 | 0.009 | 0.010 | 0.007 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.019 | <0.001 | <0.0002 | <0.002 | 58 |
| ML-9S | 12-03-86 | CH2M HILL | 37807 | <0.050 | <0.0025 | 0.009 | <0.010 | 0.006 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.031 | <0.001 | <0.0002 | <0.002 | 54 |
| ML-10S | 12-05-86 | CH2M HILL | 37825 | <0.050 | <0.0025 | <0.008 | 0.038 | <0.005 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.019 | 0.002 | <0.0002 | <0.005 | 156 |
| ML-11S | 12-03-86 | CH2M HILL | 37809 | <0.050 | <0.0025 | 0.011 | 0.011 | 0.010 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.012 | <0.001 | 0.0002 | <0.005 | 22 |
| ML-12S | 12-04-86 | CH2M HILL | 37826 | <0.050 | <0.0025 | <0.008 | 0.013 | <0.005 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.018 | 0.002 | <0.0002 | <0.005 | 104 |
| ML-13D | 12-05-86 | CH2M HILL | 37827 | <0.050 | 0.0038 | <0.008 | 0.013 | 0.006 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.073 | <0.001 | 0.0003 | 0.085 | 88 |
| ML-14D | 12-03-86 | CH2M HILL | 37828 | <0.050 | 0.0063 | 0.011 | 0.018 | 0.031 | 0.05[illegible] | <0.025 | <0.0025 | <0.050 | 0.230 | <0.018 | 0.0006 | <0.005 | 204 |
| ML-15D | 12-03-86 | CH2M HILL | 37810 | <0.050 | 0.0380 | 0.040 | 6.800 | 0.065 | 0.330 | <0.025 | 0.015 | <0.050 | 1.140 | 0.029 | <0.0017 | <0.005 | 7,400 |
| MLSW-7 | 12-01-86 | CH2M HILL | 37752 | <0.050 | <0.0025 | <0.008 | <0.010 | <0.005 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.022 | <0.001 | 0.0002 | 0.005 | 198 |
| ML-9D Duplicate (ML-9S) | 12-03-86 | CH2M HILL | 37808 | <0.050 | <0.0025 | 0.010 | 0.010 | 0.008 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.017 | 0.020 | 0.0002 | <0.002 | 70 |
| Bailer Blank | 12-04-86 | CH2M HILL | 37829 | <0.050 | <0.0025 | <0.008 | 0.021 | 0.009 | <0.013 | <0.025 | <0.0025 | <0.050 | 0.240 | <0.001 | <0.0002 | <0.005 | 492 |

[a]Groundwater samples only. Locations and sampling parameters in accordance with 9-30-86 SOW. Refer to Figure 16 for monitor well locations.

[b]Analyses pursuant to EPA Method 200.7.

[c]Analyses pursuant to EPA Methods 206.2, 245.1, and 270.2 for arsenic, mercury, and selenium, respectively.

[d]Total dissolved solids measured as filterable residue pursuant to EPA Method 160.1.

[e]Not analyzed.

[f]Secondary drinking water MCL.

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1,2-dichloroethane, dichloromethane, toluene, and vinyl chloride were the primary constituents detected in L-10S which had a total VOC concentration of 101 ug/l.

The base/neutral and acid extractable organics results and the petroleum hydrocarbon results for Site 1 are shown in Part II of Table 11 . Bis(2-ethylhexyl)phthalate was detected in six of the twelve samples collected. However, experience indicates that these concentrations may be due to the fact that bis(2-ethylhexyl)phthalate is a plasticizer used in PVC, a primary well construction material. This is supported in that Well L-7S, located hydraulically upgradient from Site 1, contained the highest levels of the constituent.

As with the VOC results, Wells L-2 and L-10S had the highest levels of base/neutral and acid extractable organics concentrations detected at Site 1. Cresol, naphthalene, phenol, diethyl phthalate, substituted hexanoic acids, and benzene acetic acid were all detected in L-2. Bis(2-ethylhexyl)phthalate, cresol, naphthalene, phenol, and diethyl phthalate were all detected in L-10S.

Petroleum hydrocarbons, a measure of oil and grease and other non-specific hydrocarbons, were detected in seven of the twelve monitor wells sampled at Site 1. They were, however, also detected in significant concentrations in the two travel blanks and in Water Supply Well No. 7. These data reflect the variability inherent in the test procedure, as explained in Section 4.1.3.3. A high petroleum hydrocarbon concentration could be an indicator of contamination with fuels or other petroleum products, such as hydraulic fluids.

The inorganics and TDS results for Site 1 are shown in Part III of Table 11. The TDS concentration of 7,400 mg/l measured in L-15D is significantly higher than the Lowndes County average of 165 mg/l (see Table 4). This may reflect the presence of cement grout exfiltrate from well construction. Field data obtained during water quality investigations (see Appendix D) indicated a high pH in the water from this well which may also reflect the grout exfiltrate. The elevated levels of metals measured in the samples collected from that well may be related to the residual solids in the water. The concentrations of 6.800 mg/l for chromium and 1.140 mg/l for zinc are one order of magnitude higher than the concentrations detected in the other monitor wells.

Cadmium, chromium, copper, and zinc were the most frequently detected inorganics at Site 1. Excluding L-15D, inorganics were most frequently detected in Monitor Wells L-2 and L-14D. Cadmium levels were at or near the MCL of 0.010 mg/l

for most new shallow monitor wells (i.e., L-7S, L-8S, L-9S, and L-11S) and also in Wells L-1, L-2, and L-14D. The chromium concentration in Well L-2 was 0.170 mg/l, which exceeds the drinking water MCL of 0.050 mg/l. L-2 had the highest chromium concentration of all the monitor wells except L-15D. L-2 was the only monitor well with a detectable lead concentration which measured 0.080 mg/l and exceeded the MCL of 0.050 mg/l. L-14D had the highest copper, nickel, and zinc concentrations of any of the monitor wells except L-15D and slightly exceeded the cadmium MCL of 0.010 mg/l.

Based on available data, L-2 and L-10S appear to have the highest levels of contamination of the monitor wells at Site 1. L-13D is in the same area as these two wells, but is approximately 50 feet deeper. L-3 is also in the same general area. L-13D had the highest dichloromethane concentration of any of the monitor wells at 3,600 μg/l, but did not contain detectable concentrations of any other organics. The inorganic concentrations in this monitor well were generally lower than in L-2. Because inorganics tend to sorb to soils, the metals concentrations in the area would be expected to decrease with depth. However, dichloromethane is very soluble in water and is not likely to sorb to soils. In addition, it is denser than water and may tend to sink within the aquifer if present in a pure form or large quantities. The vertical gradient within the surficial aquifer could also cause dichloromethane to sink in the groundwater. These factors could explain why the dichloromethane concentration is two orders of magnitude higher in the deeper well, L-13D, than in the shallower wells, L-2 and L-10S.

The available data indicate there is low-level groundwater contamination at Site 1; however, insufficient data are available to define it's horizontal and vertical extent. Low-level contamination appears to be largely confined to the area around Monitor Wells L-10S, L-2, and L-13D. Monitor Well L-3 is in the same general area and contained concentrations of benzene, chlorobenzene, and 1,4-dichlorobenzene during WAR's 1984 sampling. L-1 and L-9S were the only monitor wells that did not contain any detectable organics contamination. Monitor Wells L-7S, L-8S, L-11S, L-12S, and L-14D had relatively low levels of detectable organics contamination.

#### 4.1.2.2 Site 2. Underground Waste Fuel Storage Area

The available water quality and soils data for Site 2 are shown in Table 12. Estimated total benzene, toluene, and xylene (BTX) concentrations for the Site 2 monitor wells are shown on Figure 28. Little organic contamination was detected in MU-1, which is across a road and downgradient

Table 12
SUMMARY OF WATER QUALITY AND SOILS DATA[a], SITE 2, UNDERGROUND WASTE FUEL STORAGE AREA, MOODY AFB, GEORGIA

| Sample Designation | Date | Sample Number | Type of Sample | Volatile Organics[b]: Benzene | Chloro-Ethane | Chloro-Form | 1,4-Di-Chloro-Benzene | 1,1-Di-Chloro-Ethane | 1,2-Di-Chloro-Ethane | 1,1-Di-Chloro-Ethene | Di-Chloro-Methane | Ethyl Benzene | Toluene | Tri-Chloro-Ethene | Vinyl Chloride | Xylene | Petroleum Hydro-carbons[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | 03-Dec-86 | 37799 | Groundwater | ND[h] | BMDL[d] | ND | BMDL | BMDL | BMDL | BMDL | BMDL | 3.3 | ND | BMDL | BMDL | 11 | 1.2 |
| MW-2 | 03-Dec-86 | 37800 | Groundwater | 2,400 | <50 | ND | <50 | <50 | <50 | <50 | <50 | 740 | ND | <50 | <50 | 1,600 | 3.6 |
| MW-3 | 03-Dec-86 | 37801 | Groundwater | 2,200 | <50 | ND | <50 | <50 | <50 | <50 | <50 | 150 | ND | <50 | <50 | 250 | 1.0 |
| MW-4 | 03-Dec-86 | 37802 | Groundwater | 600 | <50 | ND | <50 | <50 | <50 | <50 | <50 | ND | <50 | <50 | <50 | 440 | 1.9 |
| MW-5 | 03-Dec-86 | 37803 | Duplicate (MW-4) | 560 | <50 | ND | <50 | <50 | <50 | <50 | <50 | ND | <50 | <50 | <50 | 420 | 1.6 |
| MWS SPT[e] 2'-4' | 24-Nov-86 | 37586 | Soil | 0.110 | NA[f] | NA | <0.100 | NA | NA | NA | NA | <0.100 | ND | NA | NA | 0.300 | 262 |
| MWS SPT 4'-6' | 24-Nov-86 | 37587 | Soil | 0.300[g] | NA | NA | <1.000 | NA | NA | NA | NA | <1.000 | 0.290[g] | NA | NA | 5.200 | 1,010 |
| MWS SPT 6'-8' | 24-Nov-86 | 37588 | Soil | 0.036[g] | NA | NA | <0.100 | NA | NA | NA | NA | 0.410 | <0.100 | NA | NA | 1.800 | 399 |
| MWS SPT 12'-14' | 24-Nov-86 | 37589 | Soil | <0.100 | NA | NA | <0.100 | NA | NA | NA | NA | <0.100 | 0.024[g] | NA | NA | <0.100 | 438 |
| MWS SPT 30'-32' | 24-Nov-86 | 37590 | Duplicate (12'-14') | ND | NA | NA | <0.100 | NA | NA | NA | NA | <0.100 | <0.100 | NA | NA | <0.100 | NA |

[a]Locations and sampling parameters in accordance with 9-30-86 SOW. All sampling performed by CH2M HILL. Refer to Figure 18 for monitor well locations and Figure 17 for SPT boring locations.

[b]Parameters measured pursuant to EPA Method 601 (water) or SW5030/8010 (soil); or to EPA Method 602 (water) or SW5030/8020 (soil). Values expressed in micrograms per liter (water) or milligrams per kilogram (soil).

[c]Parameter measured pursuant to EPA Method 418.1 (water) or SW3550 (soil). Values expressed in milligrams per liter (water) or milligrams per kilogram (soil).

[d]Below method detection limit. Method detection limit is 1 µg/l unless otherwise indicated.

[e]Obtained during standard penetration test boring from the depth indicated.

[f]Not analyzed.

[g]Presence indicated, but less than method detection limit.

[h]Not detected. (Secondary column analysis does not confirm primary column results).

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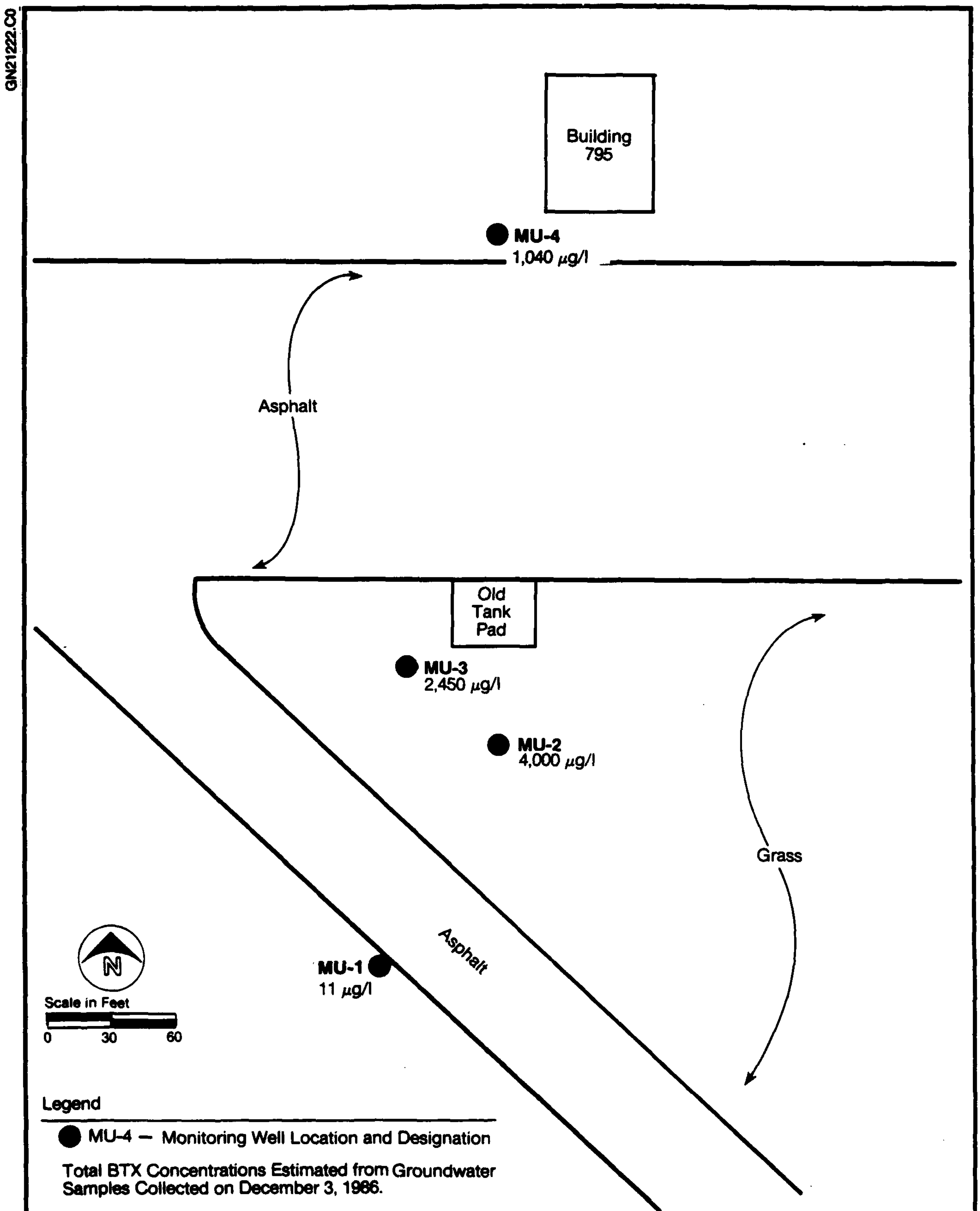


**FIGURE 28.**
**Estimated Total Benzene, Toluene, and Xylene (BTX) Concentrations, Site 2, Underground Waste Fuel Storage Area, Moody AFB, Georgia.**

from the old tank pad. Monitor Well MU-4 is across another road from the old tank pad, but is upgradient from the pad area. This monitor well had benzene and xylene concentrations of 600 µg/l and 440 µg/l, respectively, significantly higher than the concentration detected in MU-1. Monitor wells MU-2 and MU-3 are closest to the old tank pad and located in the general area of suspected highest contamination; correspondingly, they have the highest concentrations of organic contamination at Site 2. Monitor Well MU-2 is the most contaminated of the monitor wells at Site 2, with a benzene concentration of 2,400 µg/l, ethyl benzene concentration of 740 µg/l, and xylene concentration of 1,600 µg/l.

Soil samples collected near Monitor Well MU-2 confirmed the presence of benzene, ethyl benzene, toluene, and xylene contamination in the unsaturated zone underlying the site. Concentrations of VOC's and petroleum hydrocarbons were the highest in the samples collected from depths between four and eight feet. In this depth range, xylene concentrations ranged from 1.800 to 5.200 milligrams per kilogram (mg/kg). Xylene tends to concentrate in the soils instead of the groundwater because of its adsorption and solubility characteristics. Benzene is much more soluble in water and has a soil adsorption coefficient one order of magnitude less than that of xylene. This is consistent with the high concentrations of benzene detected in the groundwater and the relatively low concentrations detected in the soils.

Available data from the temporary well points and monitor wells indicate that no floating plume of JP-4 product existed in the Site 2 area investigated. A dissolved hydrocarbon plume does appear to exist, and is probably centered in the vicinity of Monitor Wells MU-2 and MU-3. The plume appears to have migrated with the regional groundwater flow and has reached Monitor Well MU-4. Significant product contamination appears to be present in the upper 10 to 15 feet of underlying soils. This contamination is probably serving as a continual source for the dissolved constituents in the groundwater, and may respond to a rising water table.

#### 4.1.2.3 Site 3. Flightline Storm Drain Outfall

The available surface water and sediment samples from Site 3 are summarized in Table 13. The surface water samples contained only trace amounts of VOC's. This would be expected because volatile organics in runoff from paved areas would likely evaporate quickly. Lead was detected in all of the surface water samples at concentrations significantly below the drinking water MCL of 0.050 mg/l. Petroleum hydrocarbons were detected in three of the five surface water samples, with the highest concentration detected in MFSW-5.

Table 13
SUMMARY OF WATER QUALITY AND SEDIMENT DATA[a], SITE 3, FLIGHTLINE STORM DRAIN OUTFALL, MOODY AFB, GEORGIA

| Sample Designation | Date | Sample Number | Type of Sample | Volatile Organics[b]: Benzene | Chloro-Ethane | Chloro-Form | 1,4-Di-Chloro-Benzene | 1,1-Di-Chloro-Ethane | 1,2-Di-Chloro-Ethane | 1,1-Di-Chloro-Ethene | Di-Chloro-Methane | Ethyl Benzene | 1,1,2,2-Tetrachloro-Ethene | Toluene | Tri-Chloro-Ethene | Vinyl Chloride | Xylene | Petroleum Hydro-carbons[c] | Lead[d] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MFSW-1 | 01-Dec-86 | 37748 | Surface Water | BMDL[e] | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | <0.6 | 0.008 |
| MFSW-2 | 01-Dec-86 | 37749 | Surface Water | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 1.2 | 0.005 |
| MFSW-3 | 02-Dec-86 | 37762 | Surface Water | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | ND[g] | <0.6 | 0.003 |
| MFSW-3 | 02-Dec-86 | 37762D | Duplicate (MFSW-3) | NA[h] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <0.001 |
| MFSW-4 | 02-Dec-86 | 37764 | Surface Water | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 1.9 | BMDL | BMDL | BMDL | 1.1 | 6.0 | 0.008 |
| MFSW-5 | 02-Dec-86 | 37766 | Surface Water | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 2.0 | BMDL | BMDL | BMDL | ND | 38.2 | 0.010 |
| -- | 02-Dec-86 | 37769 | Travel Blank | BMDL | BMDL | BMDL | BMDL | BMDL | 1.2 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | NA | NA |
| -- | 01-Dec-86 | 37753 | Travel Blank | BMDL | BMDL | BMDL | BMDL | BMDL | 1.3 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | NA | NA |
| MFSD-1 | 01-Dec-86 | 37750 | Sediment | <0.100 | <0.100 | 0.053[f] | ND | <0.100 | ND | <0.100 | ND | ND | ND | ND | ND | <0.100 | 0.370 | 464 | 1.6 |
| MFSD-2 | 01-Dec-86 | 37751 | Sediment | <0.100 | <0.100 | 0.025[f] | <0.100 | <0.100 | <0.100 | <0.100 | ND | ND | <0.100 | ND | <0.100 | <0.100 | <0.100 | 12,800 | 10.9 |
| MFSD-3 | 02-Dec-86 | 37763 | Sediment | <0.100 | <0.100 | 0.042[f] | <0.100 | <0.100 | <0.100 | <0.100 | ND | <0.100 | <0.100 | ND | <0.100 | <0.100 | <0.100 | 8,910 | 17.4 |
| MFSD-4 | 02-Dec-86 | 37765 | Sediment | <0.100 | <0.100 | ND | <0.100 | <0.100 | <0.100 | <0.100 | ND | <0.100 | <0.100 | ND | <0.100 | <0.100 | ND | 8,000 | 215 |
| MFSD-5 | 02-Dec-86 | 37767 | Sediment | <0.100 | <0.100 | 0.025[f] | <0.100 | <0.100 | ND | <0.100 | ND | <0.100 | <0.100 | ND | <0.100 | <0.100 | <0.100 | 8,030 | 21.6 |
| MFSD-6 | 02-Dec-86 | 37768 | Duplicate (MFSD-5) | <0.100 | <0.100 | 0.030[f] | <0.100 | <0.100 | ND | <0.100 | ND | <0.100 | <0.100 | ND | <0.100 | <0.100 | <0.100 | 7,000 | 26.4 |

[a]Locations and sampling parameters in accordance with 9-30-86 SOW. All samples collected by CH2M HILL. Refer to Figure 19 for sample locations.

[b]Parameters measured pursuant to EPA Method 601 (water) or SW5030/8010 (sediment); or EPA Method 602 (water) or 5030/8020 (sediment). Values expressed in micrograms per liter (water) or milligrams per kilogram (soil).

[c]Parameter measured pursuant to EPA Method 418.1 (water) or SW3550 (sediment). Values expressed in milligrams per liter (water) or milligrams per kilogram (soil).

[d]Parameter measured pursuant to EPA Method 239.2 (water) or SW3010/7420 (sediment). Values expressed in milligrams per liter (water) or milligrams per kilogram (soil).

[e]Below method detection limit. Method detection limit is 1 µg/l unless otherwise indicated.

[f]Presence indicated, but less than method detection limit.

[g]Not detected. (Secondary column analysis does not confirm primary column results).

[h]Not analyzed.

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The sediment samples from Site 3 contained relatively high concentrations of petroleum hydrocarbons and lead. The petroleum hydrocarbon concentrations ranged from 464 milligrams per kilogram (mg/kg) in MFSD-1 to 12,800 mg/kg in MFSD-2. Lead concentrations ranged from 1.6 mg/kg in MFSD-1 to 215.0 mg/kg in MFSD-4. These concentrations are comparable to lead levels found by CH2M HILL at another base, and may not be unusual for a surface water system receiving runoff from aircraft runways and adjacent paved areas. Chloroform was detected at low levels in all of the sediment samples except MFSD-4. However, chloroform is often associated with laboratory contamination at low levels (i.e., levels less than or equal to 0.025 mg/kg) because of its high volatility and common usage as a laboratory solvent.

The available data from Site 3 indicate that the sediments are contaminated with petroleum hydrocarbons. The absence of benzene, ethyl benzene, toluene, and xylene in the soils suggests that this contamination is not from fuels, but from some type of oil, grease, or other type of petroleum product which does not contain significant amounts of these compounds. For the parameters analyzed, the surface water does not appear to have significant levels of contamination.

#### 4.1.2.4 Site 4. Water Supply Well Number 10 at Grassy Pond Annex

The limited data from Water Supply Well No. 10 at the Grassy Pond Annex are presented in Table 14. CH2M HILL did not detect any VOC's in this well in 1986, but the total THM drinking water MCL was exceeded in 1985 (See Table 6). Barium was the only metal detected in the well when WAR conducted analyses for inorganics in 1984. The TOX concentration of 94 µg/l detected in 1984 by WAR may suggest organic contamination of the groundwater, but may also be related to the presence of natural organics in the groundwater.

### 4.1.3 RELIABILITY OF RESULTS

Factors that may affect results of hydrogeologic investigations presented in the above sections are discussed below, along with an assessment of the overall influence of these factors in the usefulness of the results. The factors will be addressed as they pertain to hydrogeologic and water quality areas of investigation.

#### 4.1.3.1 Hydrogeologic Investigation

The significant areas of these investigations subject to possible "error" involve characterization of subsurface conditions; measurement of groundwater levels and the

Table 14
SUMMARY OF WATER QUALITY DATA[a], SITE 4, WATER SUPPLY WELL NUMBER 10 AT GRASSY POND ANNEX, MOODY AFB, GEORGIA

| Date | Sample Number | Sampled By | Volatile Organics[b] (ppb) | TOX (µg Cl/l) | DOC (mg/l) | Oil and Grease (mg/l) | Inorganics (µg/l) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Arsenic | Barium | Cadmium | Chromium | Lead | Mercury | Selenium | Silver |
| 4/84 | -- | WAR | NA[c] | 94 | NA | <0.5 | NA | NA | NA | NA | NA | NA | NA | NA |
| 9/84 | -- | WAR | NA | NA | 4.9 | NA | <2 | 23 | <6 | <15 | <20 | <0.1 | <4 | <6 |
| 12/4/86 | 37831 | CH2M HILL | BMDL[d] | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

[a]Sampling parameters in accordance with 9-30-86 SOW.

[b]Parameters measured pursuant to EPA Methods 601 and 602.

[c]Not analyzed.

[d]Below method detection limit.



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resulting estimation of the direction of groundwater flow and gradient; estimation of the lateral hydraulic conductivity of the subsurface profile; and well development.

Subsurface sample logging during drilling is typically based on visual classifications and qualitative field indicators as to grain size and amount of fine-grained materials present. This requires qualified field personnel and has been a long-standing acceptable method of subsurface characterization. Simple manual tests have evolved over time to assist in classification procedures. Also, standardized information is available which relates the penetration resistance of the soil sampler to the type and general nature of material encountered. For this field program, field samples were also brought back to the office and checked for color and consistency. The construction of generalized geologic cross-sections through an area also requires qualified personnel, preferably those who supervised drilling operations. The field hydrogeologists developed the cross-sections for Sites 1 and 2 through comparison of field notes and samples and reduction of the profile samples into major identifiable zones with consistent characteristics.

Although based primarily on qualitative observations and indicators, subsurface characterizations for the Site 1 and Site 2 areas are considered to be representative of probable conditions. However, subsurface conditions are based on extrapolation between individual boreholes separated by a considerable distance and cannot be expected to reflect the spatial and vertical variations in geologic conditions that may actually exist.

Elevations of the groundwater surface are established by measuring down to the water surface from a point of known elevation at the top of the well casing. CH2M HILL surveyed top of casing elevations to an accuracy of 0.01 foot. Water level measurements using a steel tape can be made within the same accuracy, with conscientious effort. Thus, reported elevations are considered reliable measurements at that point in time, assuming that WAR's investigations were in accordance with the CH2M HILL accuracy stated. However, as previously discussed, representativeness of measured elevations following well completion was a consideration due to the apparently long time required for water level recovery.

Groundwater elevation contours were difficult to construct for Sites 1 and 2 because of the alignment of wells at the sites. Location of contour intervals also depends on horizontal placement of the wells on maps. Linear extrapolation between available data points was used to

construct the contours. Contours should be considered accurate only to the degree implied by the method used and only as a reasonable approximation of the probable variations in groundwater elevations over the sites. Actual levels may vary temporally and spatially from changes in hydrogeologic or other influences.

Direction of groundwater flow and gradient are based on water level contour maps and are therefore subject to the limitations of the maps. Groundwater flow occurs at approximate right angles to the contours. Gradients are established by dividing a measured difference in groundwater elevation at reference points by the estimated length of flowpath between those points. Flow direction and gradient estimates should be considered only as reasonable approximations of probable conditions.

Estimates of lateral hydraulic conductivity at specific depths and locations in the subsurface profile can be established by laboratory tests, in situ slug tests on individual monitor wells, or by full-scale pumping tests. The level of confidence in hydraulic conductivity estimates obtained generally increases with the level of field testing performed, although this can be somewhat site specific. Slug tests can yield reasonable estimates if applied properly; they best apply to wells with a minimum amount of gravel-packing and a water level considerably above the screened interval of the well. These conditions were met at Sites 1 and 2 and results obtained through the applicable analytical methods appeared consistently within a "typical" range for the type of materials encountered. However, hydraulic conductivity estimates should be considered only as reasonable approximations of actual conditions since geologic conditions, both vertically and horizontally, can vary significantly over short distances, and since results of slug tests theoretically only apply to a relatively small subsurface area adjacent to the well screen.

As previously discussed, the conditions encountered made well development difficult, particularly at Well L-15D. Slug test results from this well indicated possible well screen plugging. Field data obtained during water quality sampling indicated a high pH and conductivity in purge water for the same well (probably from residual grout/bentonite materials used during construction of this particular well). The significance of the degree of well development relates to potential effects on water quality analytical results, primarily for inorganic constituents.

#### 4.1.3.2 Water Quality Investigations

The significant areas of these investigations subject to possible "error" involve obtaining representative samples

and laboratory analysis of those samples. Obtaining representative samples for water quality analyses requires decontamination of sampling equipment to minimize cross-contamination between sampling locations and proper sample preservation and handling following collection. For groundwater monitor wells, adequate purging of the wells before sampling is also required.

Decontamination procedures used in the field program were in accordance with the SOW and reflected techniques generally considered standard in this type of work. Bailer blanks taken during the field program generally confirmed that decontamination methods were successful. Samples were properly preserved and stored following collection. Both the original and duplicate sets of samples were packaged and shipped according to the procedures discussed in applicable sections of the TOP within 24 hours of collection. Due to hydrogeologic conditions encountered, well purging was generally accomplished (per the TOP) by evacuating monitor wells entirely and sampling the wells upon partial recovery of the well water levels.

Results of duplicate samples, equipment blanks, and other laboratory quality assurance data (see Appendix F) indicate that CH2M HILL laboratory data are within acceptable limits of EPA protocol. Petroleum hydrocarbon analyses were performed by another laboratory for which quality assurance data were not available. The reliability of the petroleum hydrocarbon test data is discussed in Section 4.1.3.3.

#### 4.1.3.3 Laboratory Analyses

Even with the best laboratory procedures and protocol, several solvents commonly available in laboratories can contribute to low-level contamination in analyses for VOC's. Most frequently, these include chloroform (especially in analysis of soil samples), dichloromethane, 1,1-dichloroethane, and 1,2-dichloroethane. EPA contract labs have established variations of up to five times the detection limit as an acceptable value attributable to laboratory contamination for such parameters. Thus, the low levels of these constituents reported in Tables 11 and 13 for Sites 1 and 3, respectively, may not have been present in the waters sampled.

Bis(2-ethylhexyl) phthalate is a plasticizer in PVC and has previously been detected in samples collected from new PVC monitor wells. Considering levels reported for Well L-7S (Part III, Table 11), which is a background well upgradient from Site 1, these constituents were probably not present in the groundwater sampled to any significant degree.

The analytical procedure for petroleum hydrocarbons is a measure of the amount of residual oils, greases, and other non-specific hydrocarbons present in a sample. Within the EPA methodology for this test procedure is the following statement: "...the measurement may be subject to interferences and the results should be evaluated accordingly." The range of values reported for the travel blanks and MLSW-7 sample from Site 1 (Part II, Table 11) demonstrates the low level variability in the test procedure. The method technique produces results that appear qualitative and approximate, especially at lower concentrations. Thus, petroleum hydrocarbons were probably not present to any significant degree in water phase samples from Sites 1, 2, or 3. However, the higher concentrations reported for Site 2 subsurface samples (Part II, Table 11) and Site 3 sediments (Table 13) are considered as qualitative indicators that gross hydrocarbon contamination was present at the sampling points.

Analyses for inorganics in Well L-15D at Site 1 (Part III, Table 11) showed elevated levels for most metallic constituents. These values are probably associated with the high TDS measured in the well water. The levels may also reflect the chemical composition of remaining residual grout/bentonite materials used during construction of this well. Considering MCL's for copper, silver, zinc, and arsenic, the elevated levels indicated are not significant. Levels for antimony, selenium, lead, and mercury were below detectable limits. Levels of cadmium and chromium were above MCL's. Beryllium and nickel have no MCL's but observed concentrations exceeded EPA water quality criteria (see Table 18).

Chromium, copper, and zinc were detected in the bailer blank at Site 1 (Part III, Table 11). Organic-free water was mistakenly used for the inorganic bailer blank. The organic-free water is natural groundwater which does not contain organics, but does contain some inorganics.

### 4.1.4 Summary of Conclusions

Groundwater at Site 1 contains low levels of some VOC's and the polynuclear aromatics cresol, naphthalene, and phenols. Although the horizontal and vertical extent of the plume could not be defined, the area of contamination appears to be concentrated in the upper saturated zone of the Miccosukee Formation in the vicinity of shallow wells L-2, L-3, and L-10S (see Figure 16). High levels of dichloromethane are present in Well L-13D, which is completed in the base of the surficial aquifer. Xylenes are also present in Well L-15D, which is also a deeper well. Levels of chromium are above MCL's in Wells L-2 and possibly L-15D. Levels of cadmium are at or near the drinking water

MCL in Wells L-1, L-2, L-7S, L-8S and L-9S. Cadmium levels also appear elevated above MCL's in Wells L-14D and L-15D which are deeper wells, as well as in shallow well L-11S.

Groundwater at Site 2 is contaminated with VOC's in the vicinity of Wells MU-2 and MU-3 (see Figure 18). These shallow wells are downgradient of the old tank pad where contamination was noted when the leaking underground tank was removed. Well MU-1 is a shallow downgradient well and contains no significant levels of VOC contamination. Well MU-4 is upgradient from the area of suspected highest contamination and contains significant levels of VOC's. The unsaturated subsurface zone from land surface to about 10 to 15 feet bls near MU-2 appears to contain significant levels of hydrocarbons which are probably serving as a continual source of dissolved hydrocarbon contamination in the groundwater. It is not clear how the unsaturated zone downgradient of the old leaking tank would have become contaminated above the reported high water table of approximately 10 feet bls. Possibly higher groundwater levels naturally occur or other surface spillages have occurred in the down-gradient area. The presence of significant groundwater contamination in MU-4 upgradient of the old tank pad also suggests there are other contamination sources at this site. There does not appear to be a floating plume of JP-4 product in the area investigated, although residual product in the unsaturated zone may respond to a rising water table.

The sediments in the Site 3 area (see Figure 19) contain residual oil, grease, and other non-specific hydrocarbons. Lead concentrations appear comparable to levels found by CH2M HILL at another base, and may not be unusual for a surface water drainage system receiving runoff from aircraft runways and adjacent paved areas. Surface waters sampled do not appear to contain significant levels of VOC's, petroleum hydrocarbons, or lead.

Water Supply Well No. 10 at the Grassy Pond Annex contained no detectable levels of VOC's when it was sampled in December, 1986. The THM's detected by base personnel in 1985 did not appear to be present in December, 1986. However, the available data are not sufficient to quantify any water quality trends in this well.

## 4.2 SIGNIFICANCE OF FINDINGS

Available information on sources and uses of organic compounds was reviewed for applicability to Moody AFB. Although the organic compounds detected at Sites 1, 2, and 3 have many possible uses, only those uses which were consistent with probable past and present activities at the

base were considered. Based on this information, the current site contamination can be traced to the past activities reported at the base. The hydrogeologic and water quality data presented in Section 4.1 have been used to assess the probable migration of these contaminants, as discussed below. Available information on their eventual environmental fate is also presented.

### 4.2.1 NATURE AND SOURCE OF CONTAMINANTS

The organic compounds detected at Site 1 and the uses and sources of these compounds applicable to Moody AFB are listed in Table 15. From 1955 to 1972, the period in which the Southwest Landfill was operated, waste solvents, hydraulic fluid, paint wastes, and residue from cleaning underground fuel storage tanks were reportedly deposited in the landfill. The compounds detected in the landfill area are generally consistent with these uses. Benzene, ethyl benzene, toluene, and xylene are commonly associated with fuels and were probably present in the underground fuel storage tank cleaning residues and possibly in the hydraulic fluid disposed of in the landfill. Chloroethane, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, and trichloroethene are all used as industrial solvents. Paint stripper wastes placed in the landfill probably contained dichloromethane and phenol. Other organics detected at the site could have been present in pesticides and other chemicals which may have been disposed of in the landfill.

The organic compounds detected at Site 2 and their probable uses at Moody AFB are presented in Table 16. Benzene, ethyl benzene, and xylene are all fuel components, which is consistent with the use of this site for fuel storage. Soil samples from the site contained the same three organic contaminants plus toluene, also associated with fuels contamination. No organics that were not associated with fuels were detected at Site 2.

Organic compounds detected at Site 3 are listed in Table 17 along with their applicable uses. The flightline storm drain outfall area is reported to have received a variety of wastes over the years including waste solvents, waste oils and hydraulic fluids, and parts cleaning compounds.

1,1,2,2-Tetrachloroethene was detected in the surface water at Site 3 and is commonly used as a solvent. Xylene, detected in both the surface water and soils at the site, is a component of fuels and can be used as a solvent. Chloroform was also found, but may be the result of low level laboratory contamination.

Table 15
ORGANIC COMPOUNDS DETECTED AND THEIR USES, SITE 1, SOUTHWEST LANDFILL
MOODY AFB, GEORGIA

| Organic Compound | Applicable Uses |
|---|---|
| Benzene | Previously used as solvent<br>Octane-rising additive in gasoline before World War II, regular gasoline now contains 0.47-3.6% benzene[a] |
| Bis(2-ethylhexyl)phthalate | Plasticizer in PVC |
| Chloroethane | Solvent |
| Chloroform | Industrial solvent for pesticides<br>Laboratory solvent |
| Cresol | Component of phenolic resins<br>Surfactant<br>Disinfectant |
| 1,4-Dichlorobenzene | Mothballs<br>Air deodorant<br>Agricultural chemicals |
| 1,1-Dichloroethane | Cleaning solvent and degreaser<br>Laboratory solvent |
| 1,2-Dichloroethane | Solvent<br>Laboratory solvent |
| 1,1-Dichloroethene | Manufacture of vinyl chloride |
| Dichloromethane (Methylene Chloride) | Metal degreasing<br>Paint stripping<br>Laboratory solvent |
| Ethyl Benzene | Added to xylene and used as diluent in paint, gasoline, insecticides |
| Naphthalene | Insecticide component<br>Lubricant<br>Fungicide<br>Surfactant<br>Moth repellent |

Table 15
ORGANIC COMPOUNDS DETECTED AND THEIR USES, SITE 1,
SOUTHWEST LANDFILL
MOODY AFB, GEORGIA
(Continued)

| Organic Compound | Applicable Uses |
|---|---|
| Phenol | Component of metal finishing resins<br>Solvent for lubricants, germicidal paints<br>Disinfectant<br>Herbicide component<br>Paint strippers |
| Toluene | Paint solvent<br>Motor and aviation fuel component |
| Trichloroethene | Industrial solvent<br>Metal degreasing<br>Paint diluent |
| Vinyl Chloride | Major component of PVC |
| Xylene | Fuel component<br>Paint, insecticide solvent |

[a]Patton (1984)

Table 16
ORGANIC COMPOUNDS DETECTED AND THEIR USES, SITE 2,
UNDERGROUND WASTE FUEL STORAGE AREA
MOODY AFB, GEORGIA

| Organic Compound | Applicable Uses |
|---|---|
| Benzene | Previously used as solvent<br>Octane-raising additive in gasoline before World War II, regular gasoline now contains 0.47-3.6% benzene[a] |
| Ethyl Benzene | Added to xylene and used as diluent in paint, gasoline, insecticides |
| Toluene | Paint solvent<br>Motor and aviation fuel component |
| Xylene | Fuel component<br>Paint, insecticide solvent |

[a]Patton (1984)

Table 17
ORGANIC COMPOUNDS DETECTED AND THEIR USES, SITE 3,
FLIGHTLINE STORM DRAIN OUTFALL AREA
MOODY AFB, GEORGIA

| Organic Compound | Applicable Uses |
|---|---|
| Chloroform | Industrial solvent for pesticides<br>Laboratory solvent |
| 1,1,2,2-Tetrachloroethene | Cold cleaning<br>Vapor metal degreasing<br>Printing solvent |
| Xylene | Fuel component<br>Paint, insecticide solvent |

### 4.2.2 PUBLIC HEALTH IMPLICATIONS

The available drinking water standards, water quality criteria, and toxicity data for the contaminants detected at Sites 1, 2, and 3 are summarized in Table 18. Many of the contaminants do not have drinking water standards and there is only limited information available about their toxicity. Where available, EPA health advisory levels are given for long-term exposure to the contaminant. Available EPA ambient water quality criteria are also given. These criteria are calculated based on a given increased cancer risk (one additional case per million people) to a 70-kilogram man who ingests 2 liters of contaminated water per day and contaminated aquatic organisms for a lifetime. A bioconcentration factor that is used as an indication of the potential for a compound to bioaccumulate in fish and wildlife is also shown.

#### 4.2.2.1 Site 1. Southwest Landfill

More water quality data are available for Site 1 than for any of the other sites. This is the only site with both inorganic and organic data. Drinking water MCL's are available for four of the inorganics detected at Site 1: cadmium, chromium, lead, and selenium. All of these MCL's were exceeded at least once in the samples collected at Site 1. The cadmium standard was equaled or exceeded in five of the samples collected, while the other MCL's were exceeded only once or twice each. Although the total chromium standard was exceeded only twice, the concentration measured in L-15D in December 1986 was over 100 times the MCL; however, this relatively high concentration may be the result of residual solids in the groundwater sample.

Nickel concentrations at Site 1 exceeded the water quality criteria of 0.0134 mg/l in three of the samples collected. Because beryllium is a potential carcinogen, its water quality criterion is much lower, 0.0068 μg/l. The detection limit for beryllium in water is 2.5 μg/l; therefore, all detectable concentrations of beryllium would exceed the water quality criteria. Beryllium was detected in five of the samples collected at Site 1.

All of the inorganics detected at the Southwest Landfill site, except beryllium and nickel, have high potential for bioaccumulation. Therefore, toxicity to fish and wildlife that come in contact with contaminated groundwater upon seepage to surface waters is possible.

Few drinking water MCL's or proposed federal drinking water MCL's for organic compounds have been established. The only MCL established for any of the organics detected at Site 1 is the total THM standard of 0.10 mg/l, which applies to

Table 18
TOXICITY DATA[a]

| Parameter | Bio-Concentration Factor (estimated) | Applicable Drinking Water Standards (µg/l) | EPA Health Advisory Level Long Term (µg/l) | EPA Ambient WQ Criteria ($10^{-6}$ Cancer Risk*) (µg/l) |
|---|---|---|---|---|
| **Volatile Organics** | | | | |
| Dichloromethane (Methylene Chloride) | 0.8 | None | 150 | 0.19 |
| Chloroform | 4.5 | Total THM = 100 | None | 0.19 |
| Chloroethane | 1.3 | None | None | None |
| 1,1-Dichloroethane | 2.9 | None | None | None |
| 1,2-Dichloroethane | 1.4 | 5 (Proposed) | None | 0.94 |
| Vinyl Chloride | 0.8 | None | None | 2.0 |
| 1,1-Dichloroethene | 6.4 | 7 (Proposed) | 70 | 0.033 |
| Trichloroethene | 13 | None | 75 | 2.7 |
| 1,1,2,2-Tetra-chloroethene | 66 | None | 20 | 0.8 |
| Benzene | 6.5 | None | 230 (10 day) | 0.66 |
| Toluene | 26 | None | 340 | 14,300** |
| Ethyl Benzene | 68 | None | 3,400 | 1,400** |
| Xylene | 70 | None | 620 | None |
| Chlorobenzene | 33 | None | None | 488** |
| 1,4-Dichloro-benzene | 117 | None | None | 400** |
| **Base/Neutral Extractable Organics** | | | | |
| Bis(2-ethylhexyl) phthalate | 6,200 | None | None | 15,000** |
| Naphthalene | 95 | None | None | None |
| **Acid Extractable Organics** | | | | |
| Phenol | NA | None | None | 3,500** |
| Cresol | NA | None | None | None |

Notes: * = Based on ingestion of contaminated water and aquatic organisms.
** = Cancer risk not given.
NA = Information not available.

Table 18
TOXICITY DATA
(continued)

| Parameter | Bio-Concentration Factor (estimated) | Applicable Drinking Water Standards (μg/1) | EPA Health Advisory Level Long Term (μg/1) | EPA Ambient WQ Criteria ($10^{-6}$ Cancer Risk*) (μg/1) |
|---|---|---|---|---|
| Inorganics | | | | |
| Beryllium | Low Potential | None | None | 0.0068 |
| Cadmium | High Potential | 10 | None | None |
| Chromium | High Potential | 50 | None | 170,000** ($Cr^{+3}$) |
| Lead | High Potential | 50 | None | None |
| Nickel | Low Potential | None | None | 13.4** |
| Selenium | High Potential | 10 | None | None |
| Zinc | High Potential | 5,000 (Secondary Standard Based On Taste and Odor) | None | None |

Notes: * = Based on ingestion of contaminated water and aquatic organisms.
** = Cancer risk not given.
NA = Information not available.

[a]Harry G. Armstrong Aerospace Medical Research Laboratory (1985) and U.S. EPA (1983)

chloroform. 1,2-Dichloroethane has a proposed MCL of 5 μg/l and 1,1-dichloroethene has a proposed MCL of 7 μg/l. The proposed MCL for 1,2-dichloroethane was exceeded in one sample collected at Site 1.

Vinyl chloride and benzene are both known carcinogens, although drinking water MCL's have not been promulgated for them. In addition to being carcinogenic, benzene also has a high potential for bioaccumulation. Benzene was detected in wells L-2, L-3, and L-10S while vinyl chloride was detected only in wells L-2 and L-10S. All of the detected concentrations exceeded the ambient water quality criteria for benzene and vinyl chloride of 0.66 μg/l and 2.0 μg/l, respectively.

Chloroform, 1,1-dichloroethene, and dichloromethane are all suspected carcinogens and have high potential for bioaccumulation. They were detected in one or more monitoring wells in concentrations exceeding the ambient water quality criteria.

#### 4.2.2.2 Site 2. Underground Waste Fuel Storage Area

Benzene, ethyl benzene, and xylene were the only organics detected in monitor wells at Site 2. Soil samples collected at the site also contained these three organics in addition to toluene. Benzene is a known carcinogen and was detected in all the monitoring wells sampled except for MU-1. The measured concentrations of benzene ranged from 560 to 2,400 μg/l, several orders of magnitude higher than the ambient water quality criteria.

Ethyl benzene, toluene, and xylene are potential carcinogens. Long-term health advisory levels of 3,400, 340, and 620 μg/l have been established for ethyl benzene, toluene, and xylene, respectively. These advisory levels were exceeded only once in the groundwater samples collected at Site 2. The xylene concentration measured in MU-2 was 1,600 μg/l.

#### 4.2.2.3 Site 3. Flightline Storm Drain Outfall

1,1,2,2-Tetrachloroethene and xylene were detected in the surface water at Site 3 while chloroform, dichloromethane, and xylene were detected in the soils. 1,1,2,2-Tetrachloroethene is a suspected carcinogen and was detected in two locations in the surface water at concentrations exceeding the ambient water quality criteria of 0.8 μg/l. This VOC has a high tendency to bioconcentrate.

Chloroform is a suspected carcinogen and was detected in the soils at several locations at Site 3.

#### 4.2.2.4 Site 4. Water Supply Well Number 10 at Grassy Pond Annex

Only limited historical data are available for Moody Water Supply Well No. 10. This well at the Grassy Pond Annex was sampled by base personnel in February 1985, at which time it exceeded the drinking water standard for total THM's. When CH2M HILL sampled this well again in December 1986, no VOC's were detected. Chloroform, one of the THM's detected in February 1985, is a suspected carcinogen; however, it is not clear whether groundwater is still contaminated with chloroform in the Site 4 area.

### 4.2.3 ENVIRONMENTAL FATE OF CONTAMINANTS

Available physiochemical data and environmental fate information for the organic compounds detected at Sites 1, 2, 3, and 4 are presented in Table 19. The same type of information for the inorganic compounds detected is presented in Table 20. A review of the available information shows similarities in behavior and properties within different chemical groups.

#### 4.2.3.1 Volatile Organics

A review of the liquid density, solubility in water, Kow, Koc, and Henry's constant for an organic compound provides an indication of how the contaminant is likely to behave in groundwater. Site specific conditions such as groundwater pH and temperature, hydraulic gradient, chemical and hydraulic characteristics of the aquifer materials, and biological activity in the aquifer can have significnt affects on the fate and transport of contaminants in the groundwater. Therefore, field data are necessary to confirm the predominant fate and transport processes actually occurring at a site.

The chemical constants for the VOC's detected at Moody AFB were reviewed to evaluate how they are likely to behave in the groundwater. The liquid densities were used to evaluate a contaminant's tendency to float or sink in relation to the water in the aquifer. The octanol-water partition coefficient (Kow) and soil adsorption coefficient (Koc) were used to indicate whether a contaminant will tend to sorb to soils or remain in the aqueous phase. If the Kow and Koc values for a given VOC are high, the contaminant is likely to sorb to soils and its movement through the aquifer will be retarded. If, however, these values are low and the contaminant is highly soluble in water, it is likely to be transported at close to the same rate as the bulk groundwater.

Dichloromethane (methylene chloride) was detected in samples from seven monitor wells at Site 1. This VOC is highly

Table 19

FATE AND TRANSPORT INFORMATION FOR ORGANIC CONTAMINANTS DETECTED AT MOODY AFB[a], GEORGIA

| Parameter | Solubility in Water (mg/l @ 20°C) | Liquid Density (g/ml @ 20°C) | Log $K_{OW}$ | $K_{OC}$ | Henry's Constant $\frac{atm\text{-}m^3}{mol}$ | Mobility in Soils/ Groundwater | Probable Environmental Fate: Volatilization | Hydrolysis | Biodegradation | Sorption | Oxidation | Photolysis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dichloromethane (Methylene Chloride) | 13,200 | 1.325 | 1.25 | 9 | 0.00257 | High | High | Low | Low | Low | Low--Limited Data | Low |
| Chloroform | 8,220 | 1.485 | 1.97 | 44 | 0.00375 | High | High | Low | Low | Low--Limited Data | High in Sunlight | Low |
| Chloroethane | 5,700 | 0.9214 (0°C) | 1.43 | 15 | 0.011 | High | High | Low | Low | Low | Low | NA |
| 1,1-Dichloroethane | 5,500 | 1.175 | 1.79 | 30 | 0.0057 | High | High | Low | Low | Low | Low | NA |
| 1,2-Dichloroethane | 8,690 | 1.253 | 1.48 | 14 | 0.0011 | High | High | Low | Low | Low | Low | NA |
| Vinyl Chloride | 1,100 | SP GR = 0.9121 | 1.23 | 8 | 0.695 | High | High | Low | Low | Low | Moderate | Moderate |
| 1,1-Dichloroethene | 400 | 1.214 | 2.13 | 65 | 0.154 | High | High | Low | Low | Low | NA | Low |
| Trichloroethene | 1,000 | 1.462 | 2.42 | 127 | 0.00892 | Moderate | High | Low | Low | Moderate | Low | Low--Limited Data |
| 1,1,2,2-Tetra-chloroethene | 150 | 1.625 | 3.14 | 665 | 0.0227 | Moderate | High | Low | Low | Low | Low | NA |
| Benzene | 1,780 | 0.8765 | 2.13 | 65 | 0.00543 | Moderate | High | Low | Low | Low | Low | Low |
| Toluene | 515 | 0.8669 | 2.73 | 259 | 0.00661 | Moderate | High | Low | High After Acclimation | Moderate--Limited Data | None | None |
| Ethyl Benzene | 152 | 0.867 | 3.15 | 681 | 0.0079 | Moderate | High | Low | High After Acclimation | Moderate--Limited Data | Low | None |
| Xylene | 134-213 | o-0.8802<br>m-0.8642<br>p-0.8610 | 3.16 | 691 | o-0.00494<br>m-0.00691<br>p-0.00701 | Moderate | High | Low | Moderate | NA | NA | NA |
| Chlorobenzene | 490 | 1.106 | 2.84 | 333 | 0.00346 | Moderate | High | Low | Moderate | Moderate | NA | NA |

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Table 19
FATE AND TRANSPORT INFORMATION FOR ORGANIC CONTAMINANTS DETECTED AT MOODY AFB[a], GEORGIA
(continued)

| Parameter | Solubility in Water (mg/l @ 20°C) | Liquid Density (g/ml @ 20°C) | $\log K_{OW}$ | $K_{OC}$ | Henry's Constant $\frac{atm\text{-}m^3}{mol}$ | Mobility in Soils/ Groundwater | Probable Environmental Fate: Volatilization | Hydrolysis | Biodegradation | Sorption | Oxidation | Photolysis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,4-Dichlorobenzene | 80 | 1.2475 | 3.39 | 1,180 | 0.00158 | Limited | High--Groundwater Low--Soils | Low | Low | High-- Limited Data | Low | Low |
| Bis(2-ethylhexyl) phthalate | 0.4 | 0.9861 | 3.98 | 62,000 | $2.4 \times 10^{-7}$ | Low | Low | Low | Low | High | Low | Low |
| Naphthalene | 31.7 | 1.145 | 3.30 | 962 | $4.82 \times 10^{-4}$ | Moderate | Moderate | Low | Moderate | Moderate | Moderate with Chlorine or Ozone | Moderate-- Limited Data |
| Phenol | 93,000 | 1.0576 | 1.46 | NA | $0.13 \times 10^{-6}$ | NA | Low | Low | High | Low | Moderate with High Oxygen Concentration | Low |
| Cresol | 24,000 to 31,000 | o-1.0273 m-1.0336 p-1.0178 | NA | NA | $1.4 \times 10^{-6}$ | NA | Low | Low | High | Moderate-- Limited Data | Low | High |

NOTE: NA = Information not available.

[a]American Petroleum Institute (1985), Harry G. Armstrong Aerospace Medical Research Laboratory (1985), U.S. EPA (1983), U.S. EPA (1979), and Weast (1983-1984).

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Table 20
PHYSIOCHEMICAL DATA AND ENVIRONMENTAL FATE INFORMATION FOR INORGANIC CONTAMINANTS DETECTED AT MOODY AFB, GEORGIA[a]

| Metal | Solubility in Water (mg/l) | Sorption Potential |
|---|---|---|
| Beryllium | BeO - 0.2 (30°C) | Possible at low pH |
| Cadmium | $CdCl_2$-1.4 X $10^6$ (20°C)<br>CdS-1.3 (18°C)<br>$Cd(OH)_2$-2.6 (25°C) | High |
| Chromium | $CrO_3$ - 6.17 x $10^5$ (0°C) | $Cr^{+6}$ adsorbed by organic material |
| Lead | PbO - 17 (20°C)<br>$PBCl_2$ - 9.9 X $10^3$ (20°C) | High |
| Nickel | NiS - 3.6 (18°C)<br>$NiCl_2$-6.42x$10^5$(20°C) | Coprecipitates with metal hydroxides--slightly adsorbed on organic material |
| Selenium | $SeO_2$ - 3.84 x $10^5$ (14°C) | High |
| Zinc | ZnO - 1.6 (29°C)<br>$ZnCl_2$-4.32x$10^6$(25°C) | High |

[a]U.S. EPA (1983)

water soluble, as indicated by a solubility in water of 13,200 mg/l. It has relatively low Kow and Koc values, indicating it tends to remain in the groundwater instead of sorbing to the aquifer material. These factors suggest that dichloromethane is likely to be transported at essentially the same rate as the bulk groundwater movement.

The highest VOC concentration measured at Site 1 was a dichloromethane concentration of 3600 ug/l in ML-13D. This deep monitor well is located next to a shallow well, ML-2, which had a detected dichloromethane concentration of 34 ug/l. This increase in concentration of two orders of magnitude from the shallow to the deep well could be due to the vertical hydraulic gradient noted at Site 1 combined with a dichloromethane density greater than water.

Benzene, ethyl benzene, and xylene were the only VOC's detected in the groundwater at Site 2. Benzene is relatively soluble in water and has a relatively low Koc value, indicating it is likely to remain in the groundwater instead of sorbing to soils. Ethyl benzene and xylene; however, are less soluble in water and have significantly higher Koc values. This suggests that of the three VOC's detected at Site 2, benzene is most likely to be transported offsite.

Biodegradation could significantly reduce the ethyl benzene and xylene levels in the groundwater at Site 2 if organisms in the aquifer became acclimated to these contaminants. Benzene is not as biodegradable as ethyl benzene and xylene.

#### 4.2.3.2 Base/Neutral and Acid Extractable Organics

Semi-volatile organic data are only available for Site 1. Bis (2-ethyl-hexyl) phthalate was detected at concentrations greater than 100 ug/l in samples from five monitor wells at this site. This organic compound is relatively insoluble in water and has a relatively high Koc value. This indicates that bis (2-ethyl-hexyl) phthalate is likely to sorb to soils in the aquifer and transport in the groundwater will be relatively slow.

The only other semi-volatile organic detected at Site 1 in relatively high concentrations was cresol, which was detected in ML-2 at a concentration of 150 ug/l. Cresol has a relatively high solubility in water. Koc and Kow values were not available for cresol, but available information suggests that its sorption potential may be moderate. This indicates that groundwater transport of cresol may be retarded, but is likely to be greater than for bis (2-ethyl-hexyl) phthalate. Because cresol has a relatively high potential for biodegradation, this fate could also be significant.

#### 4.2.3.3 Inorganics

The environmental fate of inorganics is generally controlled by their solubility in water and sorption to soils. Sorption is likely to be the dominant fate. Cadmium, chromium, copper, lead, selenium, and zinc all have relatively high sorption potentials. Beryllium may sorb if the pH is low and nickel may be slightly adsorbed on organic material.

Metals have varying solubilities, depending on the dominant chemical form they are in. The values given in Table 20 are indicators of expected solubility, but can vary over a wide range depending on such factors as pH and temperature. The pH and presence of other ions, such as chloride, determine which form will dominate. For instance, if the pH is low and chloride ions are present in high enough concentrations, cadmium, lead, nickel, and zinc will all tend to form chloride complexes. If the pH is high, relatively insoluble hydroxide complexes will dominate and tend to precipitate out of solution. Other metals, such as nickel, may coprecipitate with the hydroxide complexes.

Volatilization, photolysis, biological uptake, and oxidation are not generally significant fates for inorganics. However, lead and selenium both can be used by biological organisms under anaerobic conditions and volatilized.

Cadmium, chromium, copper, and zinc were the inorganics most frequently detected at Site 1. Because these metals have relatively high sorption potentials, their transport in the groundwater is likely to be retarded significantly.

### 4.2.4 GROUNDWATER TRANSPORT

Transport of dissolved constituents in groundwater is controlled by the hydraulic conductivity and porosity of the aquifer materials, and the hydraulic gradient. In the case of organic constituents, transport is also strongly influenced by the affinity of the particular compound for the aquifer material, and the organic carbon content of the material. Average groundwater velocities in the water table aquifer in the Moody AFB vicinity are estimated to be on the order of 3 feet per year (ft/yr) in the upper aquifer system and on the order of 18 ft/yr in the lower aquifer system. The contaminants detected at Moody AFB vary greatly in their affinity for soils, as discussed in Section 4.2.3.

#### 4.2.4.1 Site 1. Southwest Landfill

Groundwater flow direction at Site 1 appears to be in a northeasterly or easterly direction. Interception of contaminated groundwater flow could potentially be of

concern at several locations generally downgradiant of Site 1. Northeast of Site 1 approximately 1,000 feet downgradient is Moody Supply Well No. 6, which is used for irrigation. Moody Supply Well No. 7 is used as a potable water supply source for the Mission Lake recreational area and is approximately 3,700 feet southeast of Site 1. The presence of a thick confining bed (Hawthorn Formation) overlying the limestone would likely preclude contaminant introduction into the deeper confined aquifer that the water supply wells are completed in (assuming integrity of the existing wells). Approximately 2,700 feet southeast of Site 1 is Mission Lake, which is used as a recreational area for base personnel. The effect of Mission Lake on the local hydrogeology is not clear from available data. It is possible that groundwater contaminants from Site 1 could discharge into the Lake or migrate beneath it.

Little data are available to predict contaminant travel times; therefore, only order-of-magnitude estimates could be made for comparative purposes. Because of the low groundwater velocity in the upper aquifer system, contaminant travel times to any of the Site 1 receptors are estimated to be over 100 years, even for contaminants such as dichloromethane which would be expected to move with the bulk groundwater velocity. In the deeper aquifer system the contaminant travel times are probably less because of the higher permeability of that portion of the aquifer. Very little organic contamination was detected in the deep wells at Site 1, with the exception of dichloromethane in L-13D. Because dichloromethane has a low affinity for soils, it would probably travel close to the average groundwater velocity of approximately 18 ft/yr. A travel time to the vicinity of Supply Well No. 6 on the order of 50 years is possible, although the presence of the Hawthorn Formation would likely preclude migration of contaminants into the deeper confined aquifer (assuming integrity of the existing well).

Contaminant concentrations in groundwater decrease with increased flow path as a contaminant plume is transported through the aquifer. This reduction in contaminant levels is the result of dispersion, dilution and retardation processes. Insufficient data are available to predict how much concentrations would decrease before contaminants reached any of the Site 1 receptors.

#### 4.2.4.2 Site 2. Underground Waste Fuel Storage Area

All of the monitor wells at Site 2 were installed in the upper surficial aquifer. It appears that an approximate groundwater velocity of 3 ft/yr is applicable for Site 2 and that groundwater moves in a south-southwesterly direction. The nearest potential receptor to Site 2 could be Supply

Well No. 6, approximately 1,700 feet west of the site. Available data indicate that contaminants from Site 2 would probably take hundreds of years to reach the vicinity of Supply Well No. 6.

The observed contamination at Site 2 may not be associated with a single contaminant source at the old tank pad. Monitor Well MU-4 is approximately 165 feet upgradient from the previous location of the leaking underground tank and showed significant levels of benzene and xylene contamination. This upgradient contamination suggests that past spills or other contaminant sources may have contributed to the observed groundwater contamination at Site 2.

The observed soils contamination near MU-2 also suggests contaminant sources other than just the leaking JP-4 tank. Soils contamination with benzene and xylene was observed from depths of 2 to 8 feet, with the highest contaminant levels detected between depths of 4 to 6 feet bls. Historical information on groundwater levels at Site 2 indicate that the groundwater table is usually 10 to 20 feet bls. Thus, the observed soils contamination may not solely be the result of fluctuating groundwater levels which contaminated the unsaturated soils.

## Section 5
## ALTERNATIVE MEASURES

### 5.1 AVAILABLE ALTERNATIVES

Available alternatives, excluding mitigation and/or cleanup measures, are:

#### 5.1.1 CATEGORY 1--NO FURTHER ACTION

This option could be selected for those sites where the investigation establishes that contamination in excess of standards does not exist and is not likely to exist. This option may also be appropriate for contaminated sites where the nature of the contaminant is such that it will be reduced effectively by natural biological and/or physical actions and either will not migrate or will not migrate in concentrations threatening to human health or the environment.

#### 5.1.2 CATEGORY 2--CONTINUED MONITORING OR ADDITIONAL INVESTIGATIONS

##### 5.1.2.1 CONTINUED MONITORING

In some cases, the data may indicate that the No Further Action option is worthy of consideration but the confidence level is too low for immediate selection. Continued monitoring could establish the effectiveness of natural biological and/or physical actions and provide the confidence level that would support a decision to take no further action. Selection of this option would be appropriate provided that human health and/or environmental degradation is unlikely.

##### 5.1.2.2 CONDUCTING ADDITIONAL INVESTIGATION

If the above alternatives are not appropriate and if data are insufficient to recommend the site for IRP Phase IV actions, recommending additional investigation regarding the direction, magnitude, rate of movement, and extent of detected contaminants would be appropriate. If the data are sufficient to establish that remedial action is clearly appropriate but some additional investigation will be necessary to select appropriate remediation, this option would probably not be appropriate. Rather, in such circumstances, it may be more appropriate to recommend that Phase IV be initiated and the additional investigation necessary for selection of remediation options be conducted as part of the Phase IV action.

### 5.1.3 CATEGORY 3--LONG-TERM MONITORING OR REMEDIAL ACTION

This option would be appropriate if remedial action is indicated and sufficient information existed to support selection of the remediation method or technology. Included in remediation options is long-term monitoring. Long-term monitoring would be appropriate, for example, for sites having high concentrations of hazardous materials, but the fate and transport analyses indicate very low possibility that human or environmental receptors will come into contact with the contaminants.

## 5.2 ALTERNATIVES CONSIDERED FOR MOODY AIR FORCE BASE

All of the above alternatives were evaluated for the sites investigated by this Phase II, Stage 2 effort. Additional discussion of the options and the recommendation for each site is contained in Section 6.

# Section 6
# RECOMMENDATIONS

Based on the conditions found at each site, each of the sites can be classified according to certain USAFOEHL categories. Category 1 consists of sites where no further action (including remedial action) is required. Category 2 sites are those requiring additional effort to determine the nature, extent, and migration of contamination. Category 3 consists of sites requiring remedial actions or long-term monitoring.

The classification of Sites 1-4 covered under this Phase II, Stage 2 study is summarized in Table 21. Each site categorization is addressed in more detail below.

## 6.1 SITE 1. SOUTHWEST LANDFILL

The significant organic and inorganic groundwater quality data for Site 1 are summarized in Tables 22 and 23, respectively. Groundwater at Site 1 contains low levels of some VOC's and the polynuclear aromatics cresol, naphthalene, and phenols. Although no definable plume is apparent, the area of contamination appears to be concentrated in the upper saturated zone of the Miccosukee Formation in the vicinity of shallow wells L-2, L-3, and L-10S (see Figure 16). Significant levels of xylenes appear to be present in Well L-15D, which is a deeper well. A dichloromethane concentration of 3,600 μg/l was detected in Well L-13D, also a deeper well. Levels of chromium are above MCL's in Wells L-2 and possibly L-15D. Levels of cadmium are at or near the drinking water MCL for most shallow monitor wells (i.e., L-1, L-2, L-7S, L-8S, and L-9S). Cadmium levels also appear to be higher than MCL's in wells L-14D and L-15D, as well as in shallow well L-11S.

Shallow groundwater flows from Site 1 generally in a northeasterly direction. Deeper groundwater near the base of the Miccosukee Formation above the top of the Hawthorn confining zone may flow more easterly. Base Water Supply Well Nos. 6 and 7 and the Mission Lake drainage system appear to be the only immediate areas potentially affected by any contaminant migration. However, Supply Well No. 6 is used for non-potable purposes and both wells are constructed into limestone formations underlying the Hawthorn Formation, the primary confining zone. Additionally, preliminary estimates regarding groundwater transport of mobile contaminants under assumed worst-case conditions indicate that the travel time of constituents is relatively long. Also, natural dilution and dispersion of contaminants during transport plus in situ biodegradation that may occur would be expected to reduce concentrations.

Table 21
SUMMARY OF SITE CATEGORIZATIONS
MOODY AFB, GEORGIA

| Site Number | Site Category Classification[a] 1 (No Further Action) | 2 (Additional Data Required) | 3 (Remedial Action Recommended) |
|---|---|---|---|
| 1 | | x[b] | |
| 2 | | | x[c] |
| 3 | | x[b] | |
| 4 | | x[b] | |

[a]Categories identified pursuant to USAFOEHL guidance.

[b]Site to be reclassified upon evaluation of additional data.

[c]Refer to Table 26 for recommended alternatives.

Table 22
*ORGANIC DATA SUMMARY, SITE 1, SOUTHWEST LANDFILL*
MOODY AFB, GEORGIA

| Sample Description | Date | Volatile Organics (µg/l) Chloro-Benzene | Chloro-Ethane | Chloro-Form | 1,4-Di-Chloro-Benzene | 1,1-Di-Chloro-Ethane | 1,2-Di-Chloro-Ethane | Di-Chloro-Methane | Ethyl Benzene | Toluene | Vinyl Chloride | Xylene | Base/Neutral and Acid Extractable Organics (µg/l) m,p-Cresol | Phenol | Petroleum Hydrocarbons[c] (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | | | | | | | | | | | | | | | |
| ML-1 | 03-Dec-86 | BMDL[a] | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 7.5 |
| ML-2 | 04-Dec-86 | BMDL | 12 | BMDL | BMDL | 4.8 | 1.7 | 34 | 3.4 | 61 | 5 | 11 | 150 | 13 | <0.4 |
| ML-3 | Sept-84 (WAR) | 9.2 | BMDL | BMDL | 8.8 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | NA[b] | NA | NA |
| ML-6 | Sept-84 (WAR) | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | NA | NA | NA |
| ML-7S | 03-Dec-86 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 1.8 | ND[c] | ND | BMDL | 3.1 | BMDL | BMDL | <0.5 |
| ML-8S | 03-Dec-86 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 1.9 | ND | 2.3 | BMDL | 3.7 | BMDL | BMDL | <0.4 |
| ML-9S | 03-Dec-86 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | ND | BMDL | BMDL | <0.5 |
| ML-10S | 05-Dec-86 | 1.8 | ND | 6.3 | 4.1 | 11 | 11 | 23 | 1.8 | 11 | 18 | 5.4 | 11 | 2.8[d] | 10.9 |
| ML-11S | 03-Dec-86 | BMDL | BMDL | 1.3 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 18.8 |
| ML-12S | 04-Dec-86 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 2.3 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 11.1 |
| ML-13D | 05-Dec-86 | <500 | <500 | <500 | <500 | <500 | <500 | 3600 | <500 | <500 | <500 | <500 | BMDL | BMDL | 11.9 |
| ML-14D | 03-Dec-86 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 5.5 | BMDL | BMDL | BMDL | BMDL | BMDL | BMDL | 10.5 |
| ML-15D | 03-Dec-86 | <50 | <50 | 21[d] | <50 | <50 | <50 | ND | 130 | ND | <50 | 400 | BMDL | BMDL | 11.7 |

[a]Below method detection limit. Method detection limit is 1 µg/l unless otherwise indicated.

[b]Not analyzed.

[c]Not determined. (Secondary column analysis does not confirm primary column results).

[d]Presence indicated, but less than method detection limit.

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Table 23
INORGANIC DATA SUMMARY, SITE 1, SOUTHWEST LANDFILL
MOODY AFB, GEORGIA

| Designation | Date | Metals (mg/l) Be | Cd | Cr | Cu | Pb | Zn | TDS (mg/l) |
|---|---|---|---|---|---|---|---|---|
| Drinking Water MCL | | -- | 0.010 | 0.050 | 1.000[a] | 0.050 | 5.000[a] | -- |
| Groundwater | | | | | | | | |
| ML-1 | 12/03/86 | <0.0025 | 0.009 | 0.015 | 0.012 | <0.025 | 0.040 | 70 |
| L-1 | 9/84 (WAR) | NA[b] | <0.006 | <0.015 | NA | <0.010 | NA | NA |
| ML-2 | 12/04/86 | 0.007 | 0.009 | 0.170 | <0.005 | 0.080 | 0.064 | 100 |
| L-2 | 9/84 (WAR) | NA | <0.006 | <0.015 | NA | <0.010 | NA | NA |
| L-3 | 9/84 (WAR) | NA | <0.006 | <0.015 | NA | <0.010 | NA | NA |
| L-4 | 9/84 (WAR) | NA | <0.006 | <0.015 | NA | <0.010 | NA | NA |
| L-5 | 9/84 (WAR) | NA | <0.006 | <0.015 | NA | <0.010 | NA | NA |
| L-6 | 9/84 (WAR) | NA | <0.006 | <0.015 | NA | <0.010 | NA | NA |
| ML-7S | 12/03/86 | <0.0025 | 0.010 | 0.012 | 0.008 | <0.025 | 0.026 | 156 |
| ML-8S | 12/03/86 | <0.0025 | 0.009 | 0.010 | 0.007 | <0.025 | 0.019 | 58 |
| ML-9S | 12/03/86 | <0.0025 | 0.009 | <0.010 | 0.006 | <0.025 | 0.031 | 54 |
| ML-10S | 12/05/86 | <0.0025 | <0.008 | 0.038 | <0.005 | <0.025 | 0.019 | 156 |
| ML-11S | 12/03/86 | <0.0025 | 0.011 | 0.011 | 0.010 | <0.025 | 0.012 | 22 |
| ML-12S | 12/04/86 | <0.0025 | <0.008 | 0.013 | <0.005 | <0.025 | 0.018 | 104 |
| ML-13D | 12/05/86 | 0.0038 | <0.008 | 0.013 | 0.006 | <0.025 | 0.073 | 88 |
| ML-14D | 12/04/86 | 0.0063 | 0.011 | 0.018 | 0.031 | <0.025 | 0.230 | 204 |
| ML-15D | 12/03/86 | 0.0380 | 0.040 | 6.800 | 0.065 | <0.025 | 1.140 | 7,400 |
| Bailer Blank | 12/04/86 | <0.0025 | <0.008 | 0.021 | <0.013 | <0.025 | 0.240 | 492 |

[a]Secondary drinking water MCL.

[b]Not analyzed.

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There are no State of Georgia or federal standards for groundwater, in general, which could be used to assess potential problems with groundwater contamination. The only existing standards apply to groundwater used as a potable water supply. Also, no significant threats to human health or environmental quality appear imminent from the contamination found in the groundwater at Site 1. However, some inorganic metals contamination exists at relatively high levels in some wells. Relatively low levels of organic contamination also exist in some wells. As a result, Site 1 is recommended for Category 2 classification involving additional monitoring.

The monitoring program for Site 1 should consist of semi-annual sampling of selected wells and parameters for a minimum of 2 years. The recommended monitoring program is presented in Table 24. Following completion of this program, all data should be re-evaluated and the site categorized appropriately.

## 6.2 SITE 2. UNDERGROUND WASTE FUEL STORAGE AREA

The significant groundwater quality and soils data for Site 2 are summarized in Table 25. Shallow groundwater at Site 2 is contaminated with VOC's; the area of suspected highest contamination is in the vicinity of Wells MU-2 and MU-3 (see Figure 18). These shallow wells are downgradient of the old tank pad where contamination was noted when the leaking underground tank was removed. Well MU-1, a shallow downgradient well, contained no significant levels of VOC contamination. Well MU-4 is upgradient from the area of suspected highest contamination and contained significant levels of VOC's. The unsaturated subsurface zone from land surface to about 10 to 15 feet bls near MU-2 appears to contain significant levels of hydrocarbons which are probably serving as a continual source of dissolved hydrocarbon contamination in the groundwater. It is not clear how the unsaturated zone downgradient of the old leaking tank would have become contaminated above the reported high water table of about 10 feet bls. Naturally occurring higher groundwater levels or surface spillages may have occurred in the downgradient area. Significant VOC contamination upgradient of the pad in MU-4 also suggests there are other sources of contamination at this site. There does not appear to be a floating JP-4 plume in the Site 2 area investigated, although residual product in the unsaturated zone may respond to a rising water table.

Shallow groundwater flows from Site 2 generally in a south-southwesterly direction. Base Water Supply Well No. 6 and the Mission Lake drainage system appear to be the only immediate areas potentially affected by any contaminant

Table 24
RECOMMENDED MONITORING PROGRAM, SITE 1, SOUTHWEST LANDFILL
MOODY AFB, GEORGIA

| Well Designation | Parameters[a] | | | |
|---|---|---|---|---|
| | VOC's[b] | | BNE[c] | PPMS[d] |
| | (E601) | (E602) | (E625) | (E200.7) |
| L-1 | | | | X |
| L-2 | X | X | X | |
| L-3 | X | X | X | |
| L-10S | X | X | X | |
| L-11S | | | | X |
| L-13D | X | X | | |
| L-14D | | | | X |
| L-15D | X | X | | X |

[a]Recommended for analysis semi-annually for two years.

[b]Volatile organic compounds analyzed pursuant to EPA Methods 601/602.

[c]Base neutral/acid extractable compounds analyzed pursuant to EPA Method 625.

[d]Priority pollutant metals scan analyzed pursuant to EPA Method 200.7.

Table 25
DATA SUMMARY, SITE 2, UNDERGROUND WASTE FUEL STORAGE AREA
MOODY AFB, GEORGIA

| Sample Designation | Date | Volatile Organics[a] Benzene | Ethyl Benzene | Toluene | Xylene | Petroleum Hydrocarbon[b] |
|---|---|---|---|---|---|---|
| **Groundwater** | | | | | | |
| MU-1 | 12/03/86 | ND[c] | 3.3 | ND | 11 | 1.2 |
| MU-2 | 12/03/86 | 2,400 | 740 | ND | 1,600 | 3.6 |
| MU-3 | 12/03/86 | 2,200 | 150 | ND | 250 | 1.0 |
| MU-4 | 12/03/86 | 600 | ND | <50 | 440 | 1.9 |
| **Soils** | | | | | | |
| MUS SPT 2'-4' | 11/24/86 | 0.110[d] | <0.100 | ND | 0.300 | 262 |
| MUS SPT 4'-6' | 11/24/86 | 0.300[d] | <1.000 | 0.290[d] | 5.200 | 1,010 |
| MUS SPT 6'-8' | 11/24/86 | 0.036[d] | 0.410 | <0.100 | 1.800 | 399 |
| MSU SPT 12'-14' | 11/24/86 | <0.100 | <0.100 | 0.024[d] | <0.100 | 438 |

[a]Values expressed in micrograms per liter (water) or milligrams per kilogram (soil).

[b]Values expressed in milligrams per liter (water) or milligrams per kilogram (soil).

[c]Not detected (Secondary column analysis does not confirm primary column results).

[d]Presence indicated, but less than method detection limit.

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migration. However, Well No. 6 is used for non-potable purposes and is constructed into limestone formations underlying the Hawthorn Formation, the primary confining zone. Additionally, preliminary estimates regarding groundwater transport of mobile constituents under assumed worst-case conditions indicate that the travel time of constituents is relatively long. Natural dilution and dispersion of contaminants during transport plus in situ biodegradation that may occur would be expected to reduce concentrations.

There are no State of Georgia or federal standards for groundwater, in general, which could be used to assess potential problems with groundwater contamination. The only existing standards apply to groundwater used as a potable water supply. No significant threats to human health or environmental quality appear imminent from the contamination found in the groundwater at Site 2. However, benzene (a known human carcinogen) is present at significant concentrations in both the unsaturated soils and groundwater underneath the Site 2 area. As a result, Site 2 is recommended for Category 3 classification involving remedial action alternatives (RAAs).

Pursuant to the SOW, a matrix of possible RAAs for this site is provided in Table 26. The rationale which should be considered in selecting a RAA largely involves evaluating cost-effectiveness and technical feasibility of the options since no State of Georgia or federal standards exist for groundwater restoration and no imminent public health threat or environmental degradation as a result of the contamination is apparent. The selected RAA should remove the source of contaminants and have the capability to monitor and/or control residual contamination. As part of the selected option(s), provision for collection of additional data should be included to facilitate preliminary and final design of selected RAA measures.

## 6.3 SITE 3. FLIGHTLINE STORM DRAIN OUTFALL

The significant surface water quality and sediments data for Site 3 are summarized in Table 27. The sediments in the Site 3 area (see Figure 19) contain significant levels of petroleum hydrocarbons. Lead concentrations appear elevated but comparable to levels CH2M HILL found at another base and may not be unusual for a surface water drainage system receiving runoff from aircraft runways and adjacent paved areas. Surface waters at sampling points do not appear to contain significant levels of VOC's, petroleum hydrocarbons, or lead.

The Site 3 area of study covered only two drainage features which are tributary to Mission Lake. On the basis of the

Table 26
RECOMMENDED REMEDIAL ACTION ALTERNATIVES, SITE 2, UNDERGROUND WASTE FUEL STORAGE AREA,
MOODY AFB, GEORGIA
(CATEGORY 3 SITE)

| Alternative | Long-Term Monitoring | Contaminated Soils Removal | Groundwater Recovery | Groundwater Treatment Onsite | Groundwater Treatment Offsite | Groundwater Disposal Onsite | Groundwater Disposal Offsite | Bioreclamation (In-Situ Treatment) | No Action |
|---|---|---|---|---|---|---|---|---|---|
| 1 | X | | | | | | | | |
| 2 | X | | | | | | | X | |
| 3 | X | X | | | | | | | |
| 4 | | X | X | | X | | X | | |
| 5 | | X | X | X | | | X | | |
| 6 | | X | X | X | | X | | | |
| 7 | | | | | | | | | X |

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Table 27
DATA SUMMARY, SITE 3, FLIGHTLINE STORM DRAIN OUTFALL
MOODY AFB, GEORGIA

| Sample Designation | Date | Volatile Organics[a] | | | | Petroleum Hydrocarbons[b] | Lead[b] |
|---|---|---|---|---|---|---|---|
| | | Chloroform | Dichloromethane | 1,1,2,2-Tetra Chloroethene | Xylene | | |
| **Surface Water** | | | | | | | |
| MFSW-1 | 12/01/86 | BMDL[c] | BMDL | BMDL | BMDL | <0.6 | 0.008 |
| MFSW-2 | 12/01/86 | BMDL | BMDL | BMDL | BMDL | 1.2 | 0.005 |
| MFSW-3 | 12/02/86 | BMDL | BMDL | BMDL | ND | <0.6 | 0.003 |
| MFSW-4 | 12/02/86 | BMDL | BMDL | 1.9 | 1.1 | 6.0 | 0.008 |
| MFSW-5 | 12/02/86 | BMDL | BMDL | 2.0 | ND | 38.2 | 0.010 |
| **Sediment** | | | | | | | |
| MFSD-1 | 12/01/86 | 53[d] | ND | ND | 370 | 464 | 1.6 |
| MFSD-2 | 12/01/86 | 25[d] | 61[d] | <100 | <100 | 12,800 | 10.9 |
| MFSD-3 | 12/02/86 | 42[d] | ND | <100 | <100 | 8,910 | 17.4 |
| MFSD-4 | 12/02/86 | ND[e] | ND | <100 | ND | 8,000 | 215.0 |
| MFSD-5 | 12/02/86 | 25[d] | ND | <100 | <100 | 8,030 | 21.6 |

[a]Values expressed in micrograms per liter (water) or micrograms per kilogram (soil).

[b]Values expressed in milligrams per liter (water) or milligrams per kilogram (soil).

[c]Below method detection limit. Method detection limit is 1 μg/l unless other indicated.

[d]Presence indicated, but less than method detection limit.

[e]Not detected. (Secondary column analysis does not confirm primary column results).

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data collected under this study, it appears that the Site 3 area per se poses no significant threat to public health or environmental degradation. However, analyses for other toxic constituents in the sediments have not been performed. Also, Mission Lake is a recreational area which serves as a primary base surface drainage feature. The lake has received stormwater discharges from base areas, in addition to reported spills of solvents, waste oils, hydraulic fluids, and other chemicals, since the 1940's.

As a result, Site 3 is recommended for Category 2 classification involving additional monitoring. The area of investigation should be expanded to include portions of Mission Lake. The recommended monitoring program is presented in Table 28. Following completion of this limited program, all data should be re-evaluated and the site categorized accordingly.

## 6.4 SITE 4. WATER SUPPLY WELL NUMBER 10 AT GRASSY POND ANNEX

Water Supply Well No. 10 at the Grassy Pond Annex contained no VOC's when sampled by CH2M HILL in 1986. It is not clear whether groundwater contamination from THM's, as indicated from past base sampling efforts, remains a problem at the site.

Based on the available data, Site 4 is recommended for Category 2 classification and continued monitoring. The frequency of routine VOC monitoring should be increased from tri-annually to annually over the next three years. If these analyses continue to show no VOC problem, water quality conditions at the well site can be more confidently assessed and the site could be placed under Category 1.

Table 28
RECOMMENDED MONITORING PROGRAM, SITE 3,
FLIGHTLINE STORM DRAIN OUTFALL
MOODY AFB, GEORGIA

| Sampling Point[b] | Type of Sample | Parameters[a] | | |
|---|---|---|---|---|
| | | BNE[c] | PCB[d] | PPMS[e] |
| S-2 | Sediment[f] | X | X | |
| S-3 | Sediment[f] | X | X | X |
| S-5 | Sediment[f] | X | X | X |
| Lake[g] | Sediment[g,h] | X | X | X |
| Lake[g] | Water[g,i] | X | X | X |

[a]Recommended for one-time analysis.

[b]See Figure 19 for sampling locations.

[c]Base neutral/acid extractable compounds analyzed pursuant to EPA Method 625.

[d]Polychlorinated biphenyls analyzed pursuant to EPA Method 608.

[e]Priority pollutant metals scan analyzed pursuant to EPA Method 200.7.

[f]Sample of top 6 inches obtained pursuant to Section 10.4.4 of the TOP.

[g]Approximately 5-10 feet beyond discharge point of primary drain system into Mission Lake (about 150 feet southwest of location S-3).

[h]Core sample of sediments above discharge point location into Mission Lake.

[i]Water column sample mid-depth above discharge point into Mission Lake.